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INTERIM PROGRESS REPORT

ON

**RESEARCH INTO THE MECHANISM OF BRINE
MOVEMENT THROUGH CLAY SEAMS AROUND
BULKHEADS IN SASKATCHEWAN POTASH
MINES**

BY

M.D. HAUG & L.C. WONG

FOR

Central Canada Potash

**A CO-OPERATIVE RESEARCH PROGRAM WITH THE
GEOTECHNICAL GROUP, DEPARTMENT OF CIVIL
ENGINEERING, UNIVERSITY OF SASKATCHEWAN**

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57 pp

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1.0 EXECUTIVE SUMMARY

This research program involves triaxial permeability/volume change testing the of 200 mm diameter samples of potash rock containing clay seams. The objective of this work is to determine the significance of clay seams in the movement of brine, and in particular the movement of brine around bulkheads constructed to stop brine inflows.

Tests conducted to date have focused on the relationship between confining stress and permeability/solubility. Eleven tests have been completed using sample confining pressures of 0.69, 3.4 MPa (500 psi) and 6.9 MPa (1000 psi). Saturated NaCl brine has been used to simulate the inflow fluid.

The results of these tests show that the permeability/solubility of clay seams and surrounding potash rock is highly dependent on confining pressure. All samples lightly confined 0.69 MPa (100 psi) failed. All sample confined at 3.4 MPa (500 psi) or above allowed some brine into the sample, but no measureable permeability was recorded.

The results of this finding could be very beneficial in the design and construction of future bulkheads. While additional testing is still required, the results show that bulkheads have a much greater chance of being effective if they are installed in such a manner as to apply a force against the surrounding potash rock and clay seams, rather than just acting as a passive dam. Future work will be required to provide more details on the optimum level of pre-stressing for various inflow brine pressures, site conditions and clay seams.

2.0 INTRODUCTION

A brine inflow can be a serious threat in the potash industry. Sodium chloride rich brine is typically under saturated in potassium chloride, and thus dissolves sylvite. The dissolution of potash rock creates pathways for migration and results in rapidly increasing rates of flow in the walls of the mined entry. The brine may also migrate through clay seams and result in rapid movement of brine over considerable distances. If large enough and left uncontrolled, the inflow can eventually result in flooding of a mine. Serious inflows of this nature have occurred in the USSR, Germany and Africa in addition to Canada.

Different methods used to control brine inflow underground have been investigated by the potash industry in Canada. Two of the most effective means of halting these inflows appears to be the use of grout in the limestone formation capping the prairie Evaporite Formation and the construction of concrete bulkheads. Grouting has been used successfully in some situations to seal cracks or microfractures above the mining horizon in the Dawson Bay Formation. Bulkheads have also been used to prevent or restrict the horizontal movement of brine from flooded entries into unflooded sections of the mine. However, there is a potential that the brine contained behind a bulkhead may also migrate around the bulkhead through the potash and clay seams. Clay seams are common to all potash mines in the Saskatoon area of Saskatchewan.

The primary objective of this research program has been to study the mechanisms of brine movement through clay seams in potash mines, and to determine the factors which influence this movement. Large diameter long-term triaxial permeability/volume change tests have been conducted on 200 mm (8 in.) diameter cored clay seam and potash rock samples. These samples have been confined under confining pressures varying from approximately 695 kPa (100 psi) to 7000 kPa (1000 psi). Ten such tests were completed in 1989.

The results of this research shows that the movement of brine through clay seams is highly dependent on the stress condition in the potash. Samples lightly stressed presented little or no obstacle to the movement of brine. All of these lightly confined samples failed. Most failures were characterized by a thin hole eroded through the sample. In all cases, the location of the hole was at or very near the contact between the clay seam and the potash rock. This suggests that different levels of strain in the potash rock and the clay seams at their contact, caused by a change in stress (i.e. lowering of in situ confining stress), may be an important factor in the movement of brine through clay seams.

Micro fractures were also identified as an important factor in the movement of brine around bulkheads. It appears that these fractures and any fractures developed at the contact between the clay seams and the potash rock may be healed with the application of confining stress. Samples confined at either 3500 kPa (500 psi) or 7000 kPa (1000 psi) were nearly impermeable. This would suggest that bulkheads used in potash mines should be constructed in such a manner that an outward stress on the surrounding potash rock is applied. The only movement of brine at higher sample confining stress levels was due to dissolution of the sylvite by the NaCl brine.

3.0 TEST PROGRAM

The test program involves long-term triaxial permeability testing of potash rock containing clay seams. Tests were conducted on samples cored from Central Canada Potash near Colonsay. Photographs No. 1 and 2, (end of report), show the location where the samples were cored and the subsequent creep of potash resulting oblongated holes. No evidence of brine migration was found at these locations when the cores were taken. Additional clay seam and potash rock cores were also obtained during 1989. These samples were cored at approximately 1.8 m (5 feet) below the mining level. The locations of the cores were chosen near the future location of a bulkhead. In addition, no evidence of brine migration was observed at the location of these cores.

The core samples were 200 mm (8 inches) in diameter and 400 mm (16 inches to 600 mm (24 inches) in length. No visible cracks were found on the core samples, but microfractures might develop in the samples due to stress release. These cores were then cut to a thickness approximately 50 mm (2 inches) by a heavy duty carbide tipped band saw and placed in triaxial permeability cell for testing. This triaxial permeability cell was specially designed and constructed for this test program. The cell was constructed with type 316 L stainless steel and designed to apply pressures up to 6.9 MPa (1,000 psi). Details of this equipment and the testing procedures was outlined in detail in the January, 1989 Progress Report.

4.0 PRESENTATION OF THE TEST RESULTS

4.1 Permeability/Solubility test

A series of triaxial permeability tests were conducted on various core samples of potash rock with clay seams in order to study the hydraulic flow characteristics of this material. One long-term permeability/solubility test was performed during 1988 on a clay seam sample under a confining pressure of 6.9 MPa. Ten tests were conducted in 1989 on samples confined under various levels of stress. A summary of the test parameters for the 1989 tests is presented in Table 1. A summary of the test results for these samples is presented in Table 2.

In examining the test results it is important to note that the inflow pressure was applied vertically upward on the sample and the back pressure was applied vertically downward. This feature of the testing procedure had a considerable impact on the test results, since KCl saturated brine is heavier than NaCl saturated brine. Thus, NaCl saturated brine can dissolve upward through potash rock much more easily than it can downward. This may help to explain some of the differences between flow into the top and bottom of the samples during testing.

Test No. S009

This test was conducted in 1988. A confining pressure of 6.9 MPa (1000 psi) was used for this sample. The pressure on the top of the sample was 69 KPa (10 psi) throughout the test. The pressure on the bottom of the sample was 276 KPa (40 psi) during the first stage and was increased to 414 KPa (60 psi) during the second stage. The result that obtained from this test was similar to test S066 except it did not fail. The result of this test was presented and analysed in last year report in detail.

TABLE #1-TEST PARAMETERS

TEST No.	CONFINING STRESS (psi)	FLUID	CONFINING PRESSURES		SAMPLE THICK. (mm)	CORE NO.	COMMENTS
			BOTT. psi	TOP psi			
S009	1000	OIL	40,60	10	53.6	1	TWO 8" DIAMETER MEMBRANE 1.92 mm thick
S066	500	OIL	60	10	47.9	1	ONE 8" DIAMETER MEMBRANE 1.92 mm thick
S076	100	AIR	40	10	50.9	1	ONE 8" DIAMETER MEMBRANE 1.92 mm thick, with Vacuum Grease
S077	100	AIR	40	10	52.5	1	TWO 6" DIAMETER MEMBRANES 0.31 mm thick, with Vacuum Grease
S078	100	AIR	40	10	49.1	1	ONE 8" DIAMETER MEMBRANE 1.92 mm thick ONE 6" DIAMETER MEMBRANE 0.31 mm thick with Vacuum Grease
S084	100	AIR	40	10	49.8	4	ONE 8" DIAMETER MEMBRANE 1.92 mm thick ONE 6" DIAMETER MEMBRANE 0.31 mm thick with Vacuum Grease
S085	100	AIR	40	10	48.8	4	ONE 8" DIAMETER MEMBRANE 1.92 mm thick ONE 6" DIAMETER MEMBRANE 0.31 mm thick with Vacuum Grease
S089	100	AIR	40	10	49.6	4	ONE 8" DIAMETER MEMBRANE 1.92 mm thick ONE 6" DIAMETER MEMBRANE 0.31 mm thick with Vacuum Grease
S090	100	AIR	40	10	50.3	1	ONE 8" DIAMETER MEMBRANE 1.92 mm thick ONE 6" DIAMETER MEMBRANE 0.31 mm thick with Vacuum Grease
S108	500	OIL	60	10	47.9	1	ONE 8" DIAMETER MEMBRANE 1.92 mm thick ONE 6" DIAMETER MEMBRANE 0.31 mm thick with Vacuum Grease
S120	500	OIL	60	10	50.4	4	ONE 8" DIAMETER MEMBRANE 1.92 mm thick ONE 6" DIAMETER MEMBRANE 0.31 mm thick with Vacuum Grease

TABLE #2: TEST RESULTS

TEST NUMBER	SAMPLE WEIGHT gm	FINAL WEIGHT gm	COMMENTS
3009			SAMPLE WAS TESTED FOR 118 DAYS CHEMICAL DISSOLUTION OCCURED AT BOTTOM OF THE SAMPLE WAS MUCH MORE SIGNIFICANT THAN THE TOP
3066			SAMPLE FAILED DURING THE NIGHT AFTER SEVERAL HOURS RUN TIME HYDRAULIC FLUID LEAKED AROUND MEMBRANE AND OUT OF CELL PERMEABILITY = $2.4E-8$ cm/sec
3076			SAMPLE FAILED IMMEDIATELY AFTER START OF TEST PERMEANT FLOWED AROUND SIDES OF SAMPLE SAMPLE CRACKED ALONG POTASH/CLAY CONTACT
3077	3611		SAMPLE FAILED OVER NIGHT DUE TO MEMBRANE RUPTURE AIR FLOWED INTO BOTH PORE AND BACK PRESSURE LINES
3078	3379	3244	SAMPLE FAILED OVERNIGHT AFTER APPROX. 24 HOURS EXTENSIVE DISSOLUTION ON BOTTOM, LITTLE ON TOP OF SAMPLE 1/2" DIAM. HOLE THROUGH SAMPLE NEAR CENTRE PERMEABILITY = $4.9E-9$ cm/sec
3084	3384	3328	SAMPLE FAILED AFTER APPROX. 38 HOURS EXTENSIVE DISSOLUTION ON BOTTOM, LITTLE ON TOP OF SAMPLE 1/2" DIAMETER HOLE THROUGH SAMPLE NEAR CENTER PERMEABILITY = $4.9E-9$ cm/sec
3085	3322	3272	"O" RINGS SLIPPED ON TOP OF SAMPLE NEGATING SEAL AIR LEAK INTO BACK PRESSURE LINES PERMEABILITY = $5.4E-9$ cm/sec TEST STOPPED AFTER ONE WEEK
3088	3350	3312	SAMPLE FAILED IMMEDIATELY AFTER START OF TEST NO VISIBLE HOLES THROUGH SAMPLE TO EXPLAIN HIGH FLOW RATES SIGNIFICANT DISSOLUTION ON SAMPLE BOTTOM
3090	3481		SAMPLE FAILED IMMEDIATELY AFTER START OF TEST NO VISIBLE HOLES THROUGH SAMPLE TO EXPLAIN HIGH FLOW RATES SIGNIFICANT DISSOLUTION ON SAMPLE BOTTOM
3108			NINE CHEMICAL ANALYSIS OF BRINE PERMEANT TAKEN DURING TEST PERIOD
3120			TEST IN PROGRESS

Test No. S066

Confining stress of 3.4 MPa (500 psi) was applied to the sample. Hydraulic pressures of 69 kPa (10 psi) and 414 kPa (60 psi) were applied to the top and bottom of the sample respectively. One 200 mm (8 inches) diameter rubber membrane with a thickness of 1.92 mm (0.08 inch) was used for this sample. The flow in and out of this sample was monitored continuously for the first 5 hours, and then left running overnight. In the morning this sample had failed. Failure resulted in rapid flow through the sample, leading to sample dissolution and membrane failure. The failed membrane allowed the confining hydraulic fluid to enter the sample and the flow measuring system. A major cleanup on the system was necessary in order to run another test.

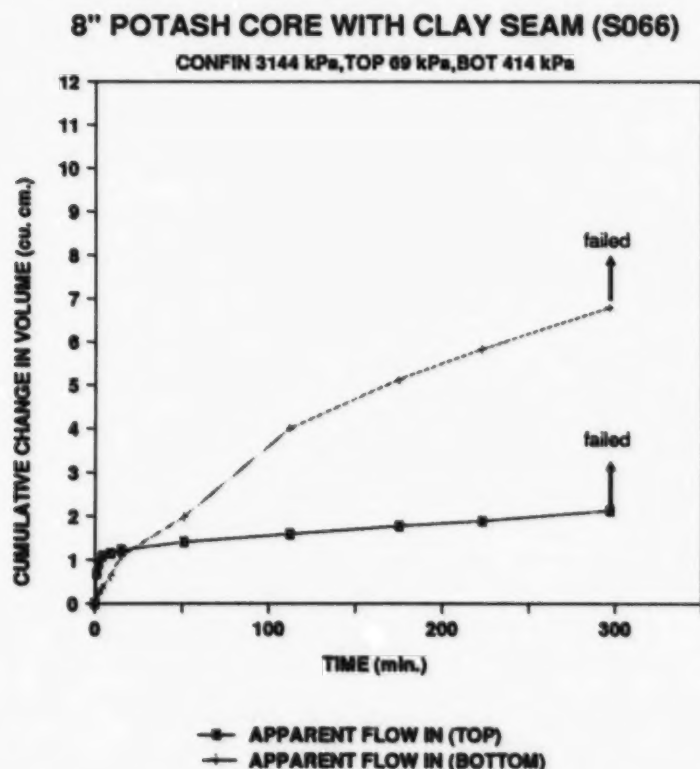
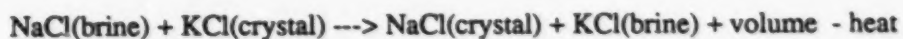


Figure 1: Volume Change Versus Time for Clay Seam Sample No. S066

The cumulative change in volume with time as a result of the dissolution of the sample at both ends was plotted against elapsed time on Figure 1. The top curve represents the change in volume with time at the bottom of the sample. The bottom curve represents the change in volume at the top of the sample. No brine passed through the sample during the first five hours, although some dissolution of both the top and bottom of the sample occurred.

The chemical dissolution occurred at the ends of the sample can be represented by the following equation:



During this endothermic dissolution, the overall volume was reduced by approximately 33 % of the original total volume. The sample was tested vertically instead of horizontally because of the limitation of the apparatus. The change in volume at the top of the sample (2.13 cu. cm./5 hours) was much slower and less significant than the change at the bottom of the sample (6.8 cu. cm/5 hours). This is because the density of the KCl brine is higher than the NaCl brine, and the KCl brine coats the top of the sample. This layer of KCl brine prevents further reaction between the NaCl brine and the KCl crystal. At the bottom of the sample, the KCl brine sinks, allowing some fresh NaCl brine to rise. The fresh NaCl brine dissolved more sylvite and resulted in a decrease in volume. This convective overturn process is represented in Figure 2.

Figure 3 shows the rate of change in volume at the top and bottom of the sample with respect to time. The term "apparent permeability" was used on the y-axis to represent the rate of change in volume at the ends of the sample. The term "Apparent permeability" used throughout this report is defined as the sum of the rate of volume change due to the chemical dissolution at the end of the sample and the true permeability through the sample. There is no brine flow through the sample during the first five hours of test S066. Thus, the "apparent

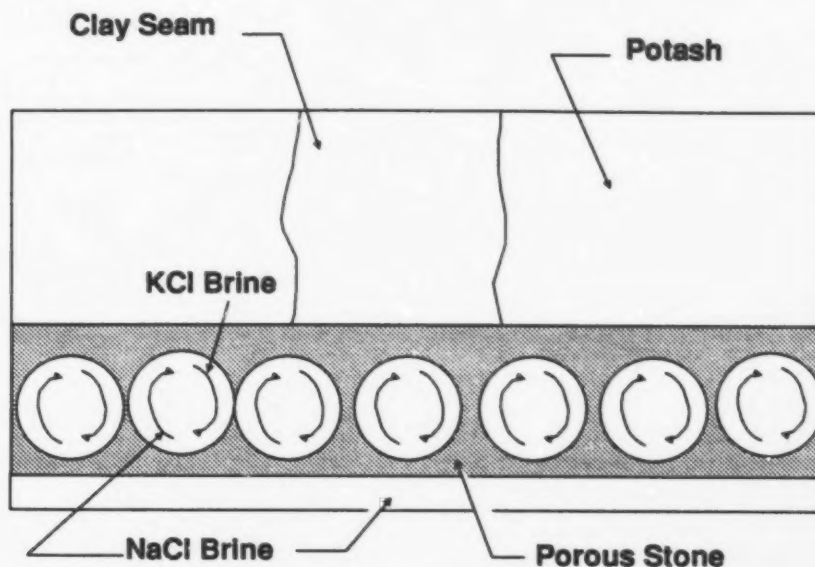


Figure 2: Convective Overturn Process.

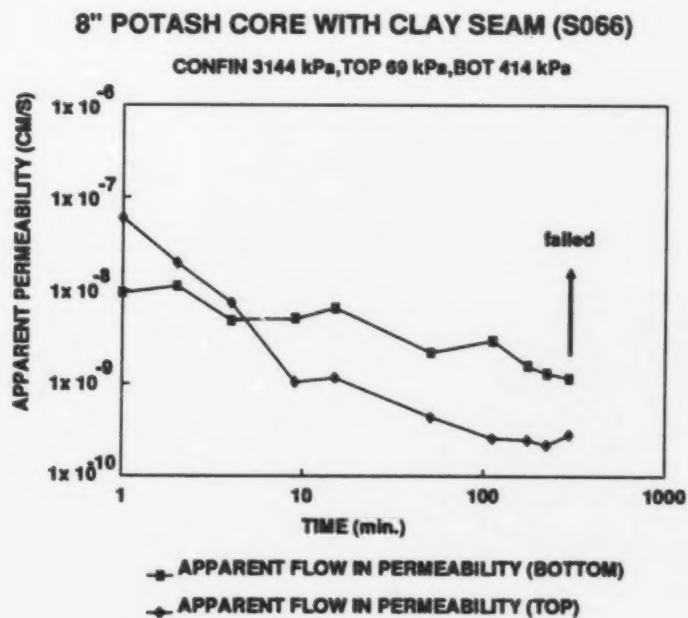


Figure 3: Apparent Permeability Versus Time for Clay Seam Sample No. S066

permeability" is equal to the rate of volume change at the end of the sample due to the chemical dissolution. The "apparent permeability" is decreasing with time because the concentration of KCl brine increased as a result of the chemical dissolution and the KCl brine protected the sample from further dissolution.

Test No. S076

A lower confining pressure of 690 kPa (100 psi) was used in this test. Air was used as the confining media for this test. The hydraulic pressures on this sample were 69 kPa (10 psi) and 276 kPa (40 psi) on the top and bottom of the sample respectively. A 200 mm (8 inches) diameter 1.92 mm (0.08 inch) thick membrane was used in this test. However, this membrane is too thick and rigid to provide a proper seal at low confining pressures. The sample failed within fifteen minutes. Brine flowed between the membrane and the sides of the samples. A crack also developed along the contact between the clay seam and the potash. This sample showed that there is a distinct weakness along the contact.

Test No. S077

The stress conditions for this test were identical to the previous test. Two 127 mm (6 inches) membranes of 0.31 mm (0.01 inch) thickness were stretched over the sample to provide a good seal between the sample and the membrane. Unfortunately, the membranes ruptured overnight as the membranes were too thin and air in the cell went into both reservoirs provided the brine fluid pressure to the sample.

Test No. S078

The stress conditions for this and the next four tests were identical to the previous two tests. Trial and error was employed to find a new procedure for sealing the samples. Using a 150 mm (6 inches) diameter membrane stretched over the sample, followed by an 200 mm (8 inches) diameter membrane provided good results. Vacuum grease was smeared on the sides of the sample and between the two membranes to ensure good contact and an impermeable boundary.

Brine flowed in at the bottom of the sample and flowed out at the top of the sample apparently during the first seven hours. An "apparent flow in permeability" of 5.1×10^{-10} cm/s was measured at the bottom of the sample and an "apparent flow out permeability" of 1.1×10^{-9} cm/s was measured at the top of the sample after seven hours. The sample failed after approximately 36 hours. The main purpose of this test was to determine a good method to seal the sample under low confining pressure. Thus, not enough data points were taken to plot a representative graph for this test.

A 1.3 cm (0.5 in.) diameter hole opened up in the sample by dissolution of the potash. This hole occurred at the contact between the clay and potash (Photo 7 and 8). Extensive dissolution occurred at the bottom of the sample (Photo 8).

Test No. S084

The stress conditions applied to this sample are identical to the previous sample. The objective of this test is to confirm the result of the previous test.

The results obtained from this sample is almost identical to the previous test. Apparently, brine flowed in at the bottom of the sample and out at the top of the sample during the first six hours. The "apparent flow in and out permeability" of the sample was measured to be the same at 4.9×10^{-9} cm/s after six hours. The sample failed at approximately 36 hours. Extensive dissolution occurred at the bottom of the sample and little on the top (Photo 9 and 10).

A 1.3 cm (0.5 in.) diameter hole through the sample was also observed. This hole is very similar to the hole that occurred in the previous sample (Photo 9 and 10).

Figure 4 shows the graph of "apparent permeability" versus time for sample S084.

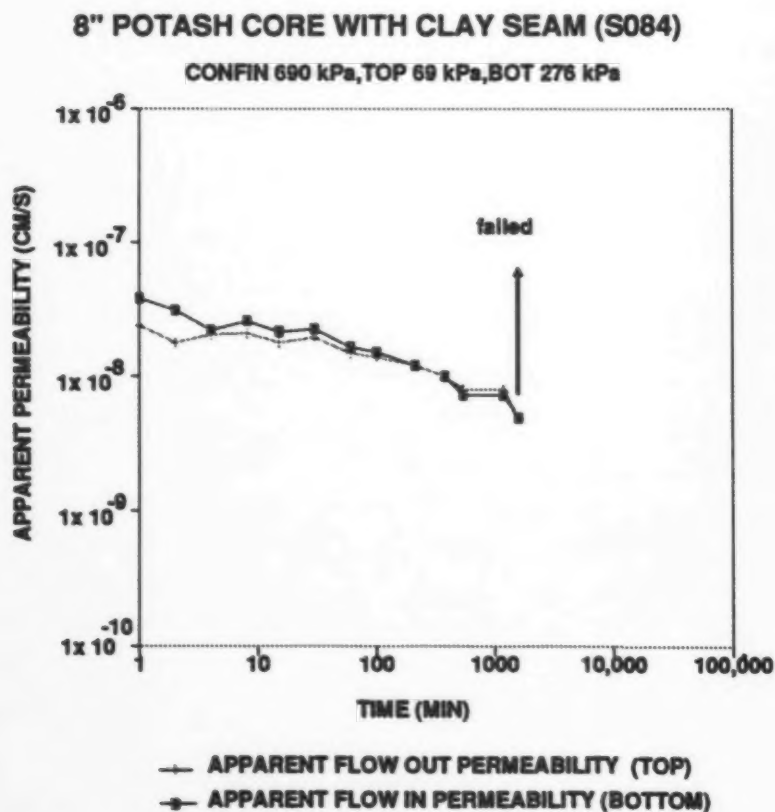


Figure 4: "Apparent Permeability" Versus Time for Clay Seam Sample No. S084

Test S085

Identical stress conditions were applied to this samples as in the previous test. This test failed in a strange manner and was believed due to an air leak at the top of the sample. The sample was sealed for the first three hours and air went into the top of the sample. An average permeability of 5.4×10^{-9} cm/s was measured before the sample failed. An O-ring was found to slipped out from the top of the sample inside the cell which caused the failure. Figure 5 shows the relationship between the measured "apparent permeability" and time for sample S085 before failure.

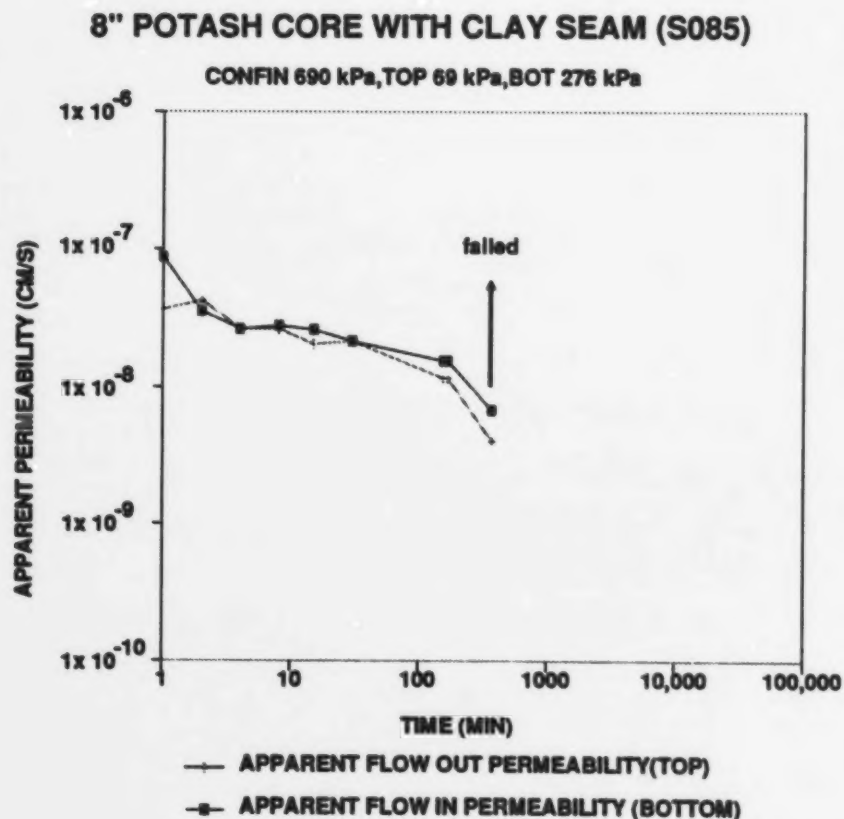


Figure 5: "Apparent Permeability" Versus Time for Clay Seam Sample No. S085

Test S089 and S090

These two samples were subjected to the same stress conditions as the previous five tests. They failed almost immediately after the test started. The failures were similar despite being from different cores. No permeability values could be determined from the tests because the flow rates exceeded the capacity of the measuring system. Unlike test S084 and S085, no holes were visible through the samples. Large areas of dissolution were evident on the base hinting that a tortuous flow path could have opened along grain boundaries (Photo 13 and 14).

Test S108

A confining stress of 3.4 MPa (500 psi) was applied on the sample for this test. Hydraulic pressures of 69 kPa (10 psi) and 414 kPa (60 psi) were applied to the top and bottom of the sample. One 200 mm (8 inches) diameter and 150 mm (6 inches) diameter membrane was used for this test. This sample did not fail in the same manner as the other samples subjected to lower confining pressure. This test was run for 50 days and its "apparent permeability" at both ends was down to the 2×10^{-11} cm/s range. The low "apparent permeability" of this sample might be caused by the saturated KCl solution preventing further dissolving of potash at both ends of the sample. Nine permeant samples were collected from the top of the sample and analysed at different time intervals. The results of the chemical analysis are presented in the Appendix. These analysis showed that the concentration of the potassium increased from approximately 4500 mg/liter to 50000mg/liter and the concentration of the sodium ion decreased from 93000 mg/liter to 75000 mg/liter. Figure 6 shows the "apparent permeability" of

sample S108 versus time. The erratic curve shown on the graph was caused by the disturbance of the flow while taken the permeant samples and the "apparent permeability" values were down to and exceeds the capacity of the apparatus.

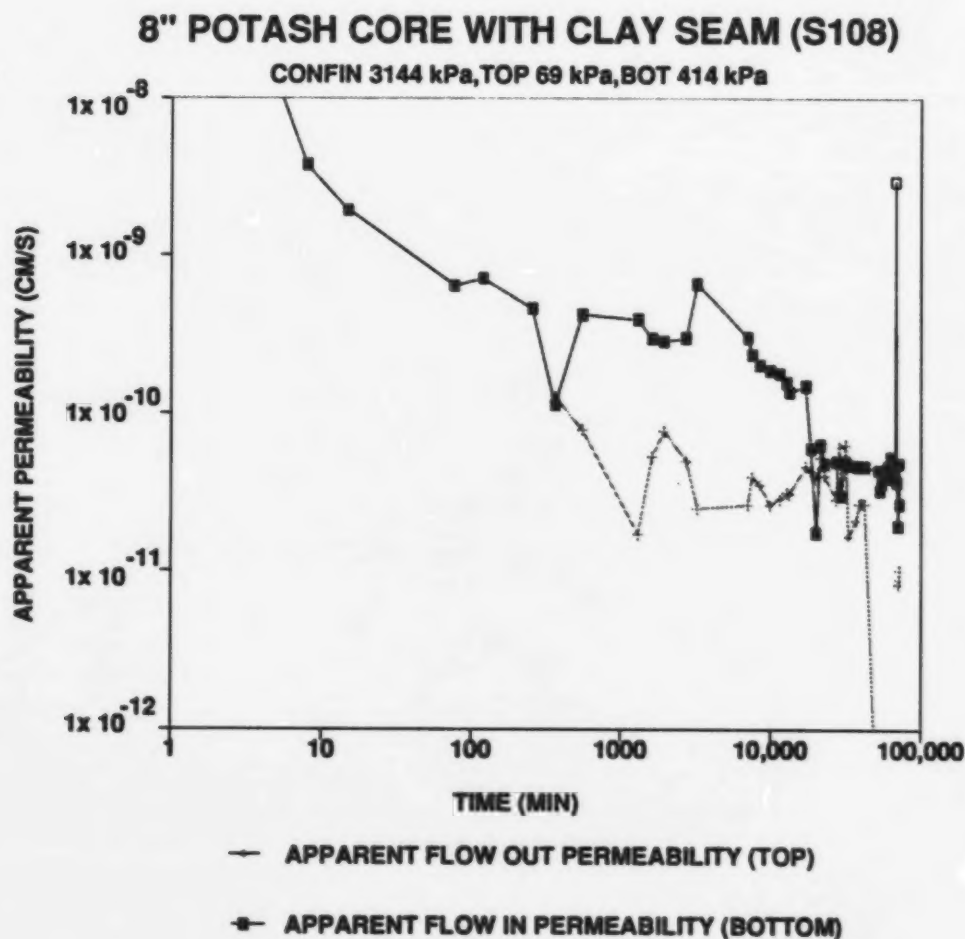


Figure 6: "Apparent Permeability" Versus Time for Clay Seam Sample No. S108

Test S120

This sample was tested using the same condition as test S108 and the sample had not fail after 20 days. This test was still in process at the end of December, 1989. Figure 7 shows the "apparent permeability" versus time for this sample up to the end of December, 1989. The objective of this test is to decrease the confining pressure gradually to see if the sample fails.

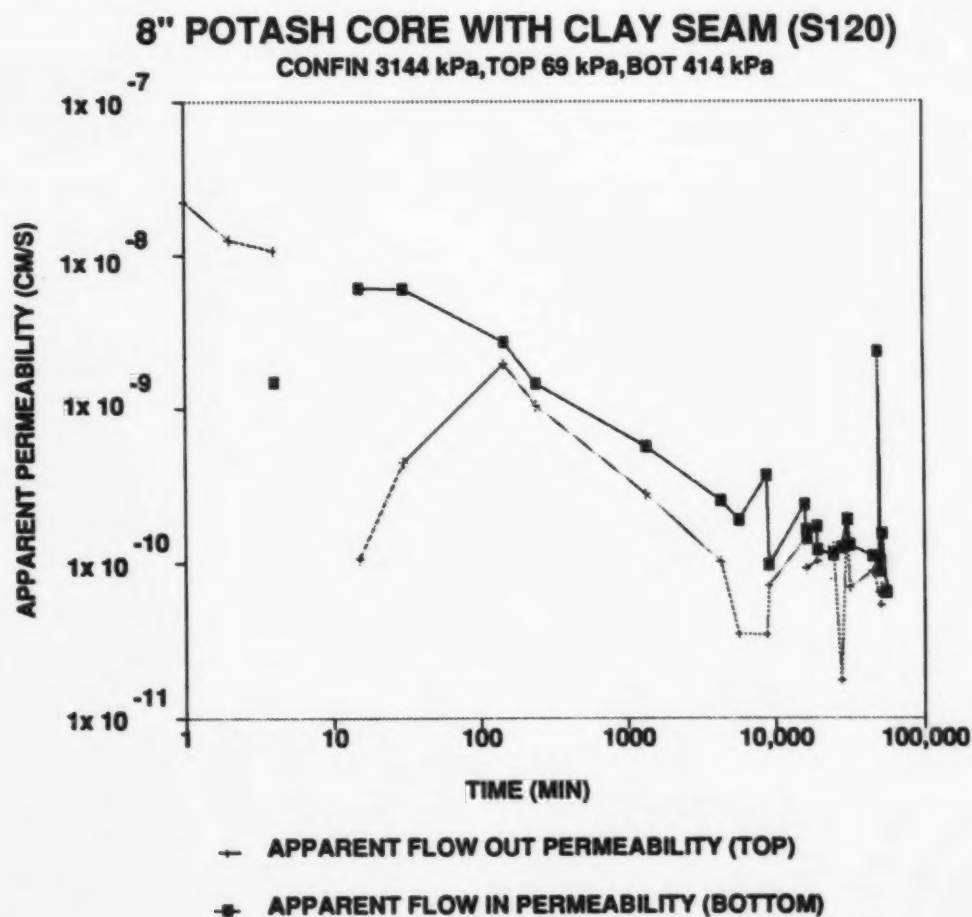


Figure 7: "Apparent Permeability" Versus Time for Clay Seam Sample No. S120

4.2 Mineralogical and Chemical Test

RESULTS OF X-RAY DIFFRACTION ANALYSIS ON CLAY SEAM

	BEFORE PERMEABILITY TEST (wt. %)	AFTER PERMEABILITY TEST (wt. %)
QUARTZ	16.9	30.3
K-FELDSPAR	8.7	6.3
DOLOMITE	65.7	56.1
ILLITE	1.8	4.4
SEPTECHLORITE	6.8	0.0
TRI CHLORITE	0.0	2.9

5.0 SUMMARY AND CONCLUSIONS.

- 1) Ten triaxial permeability/volume change test have been complete.
- 2) Successful tests showed that three processes were taking place:
 - a) Below 3.4 MPa (500 psi) confining pressure, stress relieved samples subjected to confining pressures and tested shortly after the application of pressure had sufficient microfractures to allow solutioning and passage of brine through the samples giving an "apparent permeability". This apparent Permeability had both a measureable true permeability as well as a solutioning component.
 - b) Solutioning of sylvite by NaCl rich brine gives an "apparent permeability" with no component from the true permeability at confining pressures above 3.4 MPa (500 psi).
 - c) Creep takes place due to lateral confining pressure. This pressure appears to close the microfractures in both potash and clay seams. The effect of this closure can be observed when sylvite crystals on the top of the sample penetrate the KCl brine blanket layer to be dissolved by the superincumbent NaCl brine, thus giving rise to continued solutioning at the top in spite of the KCl brine blanket.
- 3) Analysis of these interactions leads to the conclusion that clay seams in the mining horizon may not have a measureable permeability provided the potash and clay seams have a confining pressure equal to or in excess of 3.4 MPa (500 psi.). Below that level of confinement rapid solutioning may be expected.
- 4) An important component of next years research will be to determine if the presence of solubility suppressants in the backpressure fluid can be used to minimize the permeability/solubility of lightly confined potash rock and clay seams.

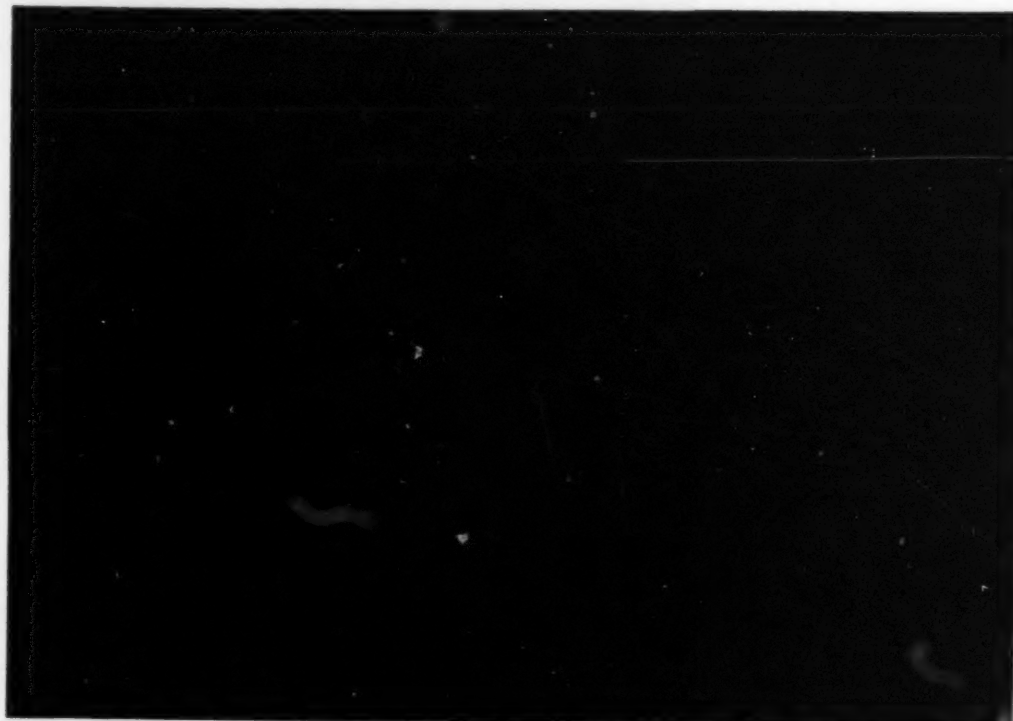


Photo No. 1: Location of Core Hole Used to Obtain Clay Seam Sample

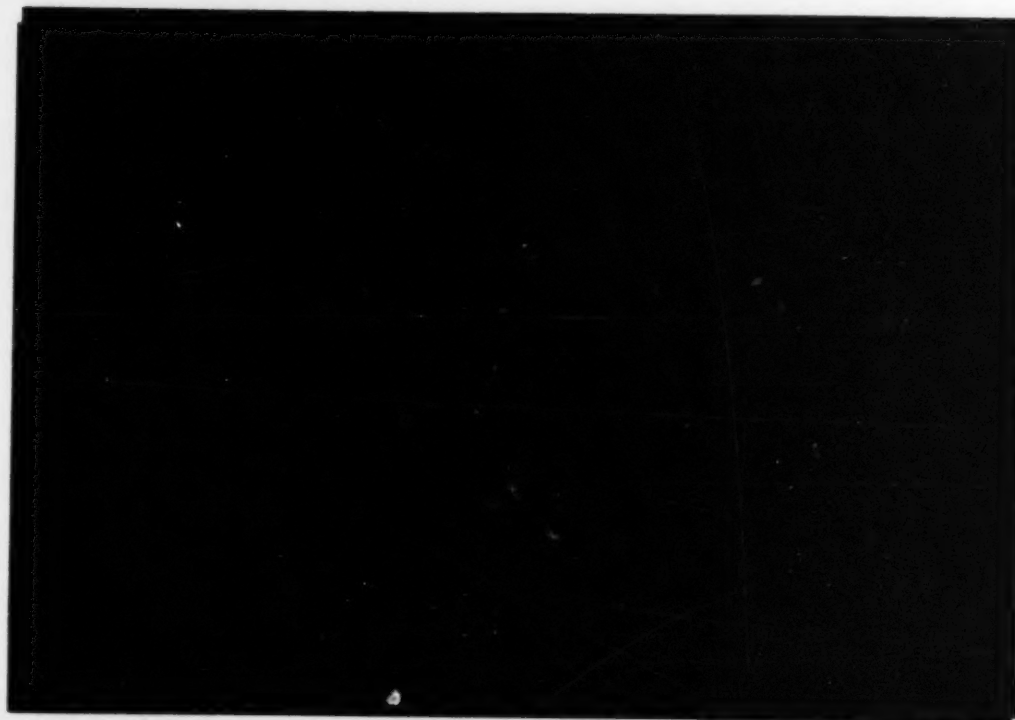


**Photo No. 2: Location of Twin Core Holes Used to Obtain Clay Seam
Samples**

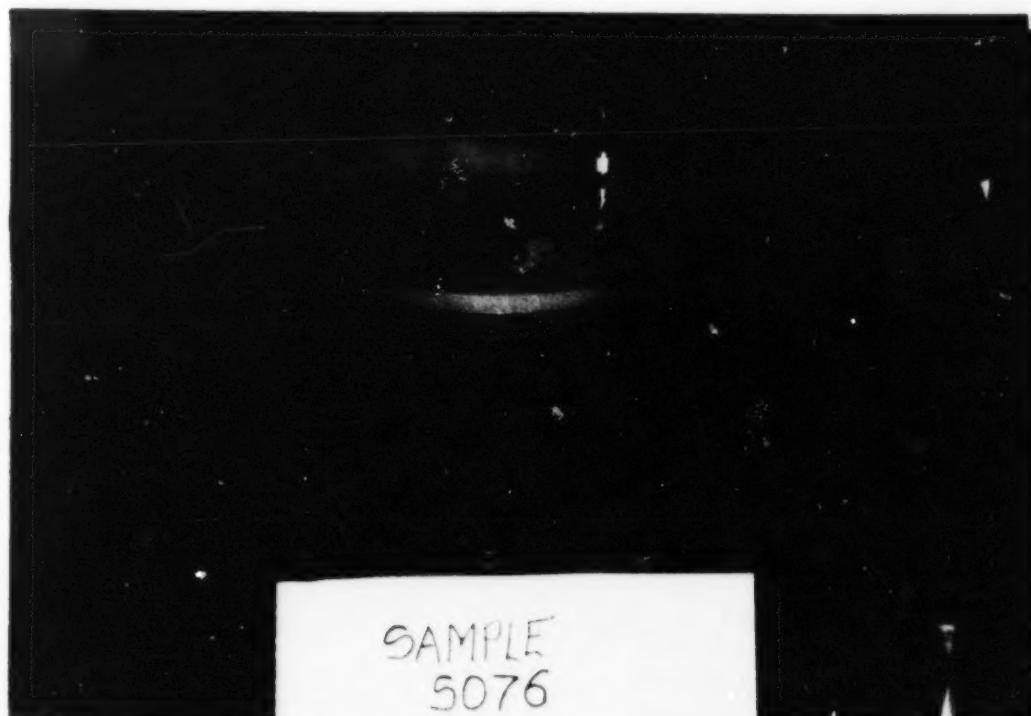


Photo No. 3: Sample No. S076 Prior to Testing

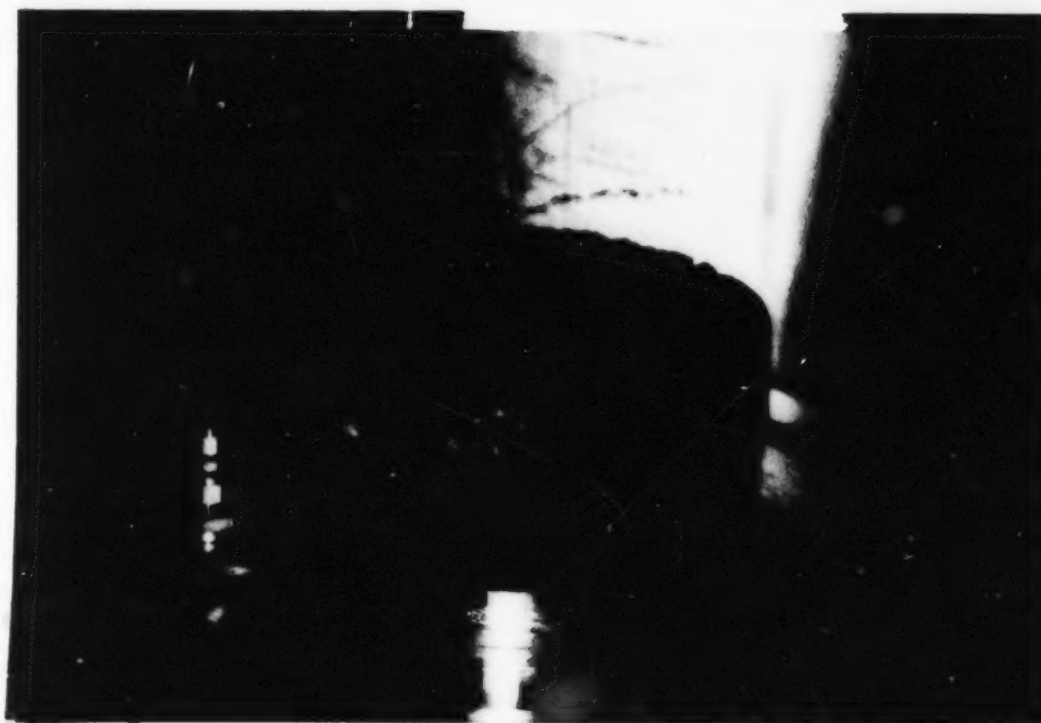


**Photo No. 4: Sample No. S076 Following Testing Showing Crack Through
Clay Seam.**

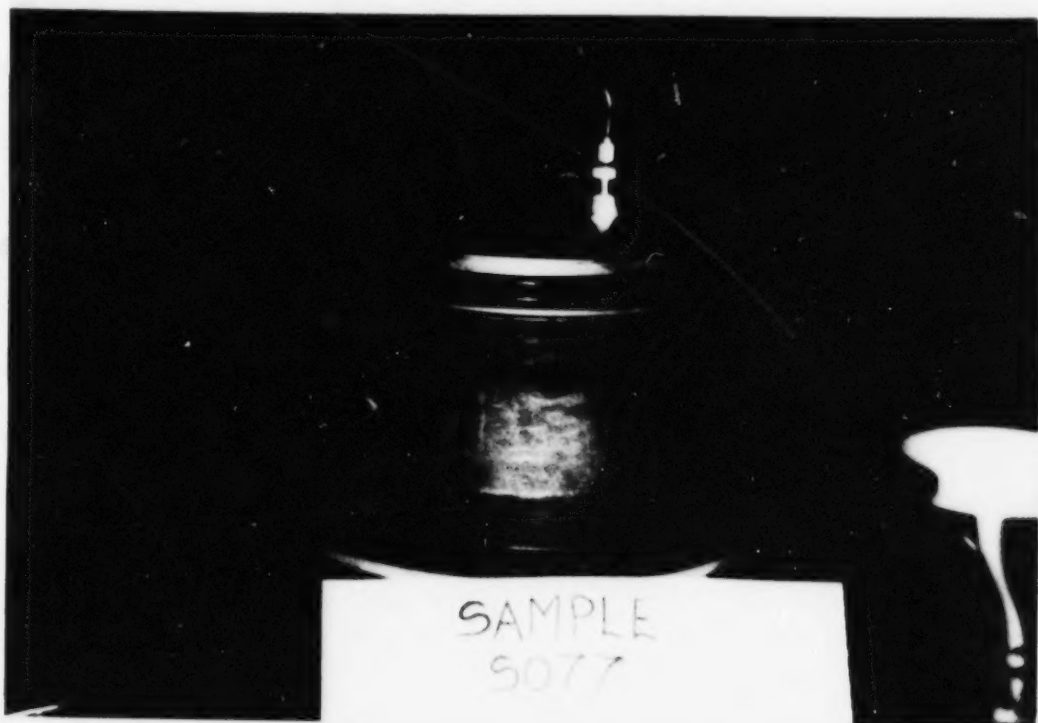


Photo No. 5: Sample No. S077 Prior to Testing, Showing Thin Membrane



Photo No. 6: Sample No. S077 Following Testing

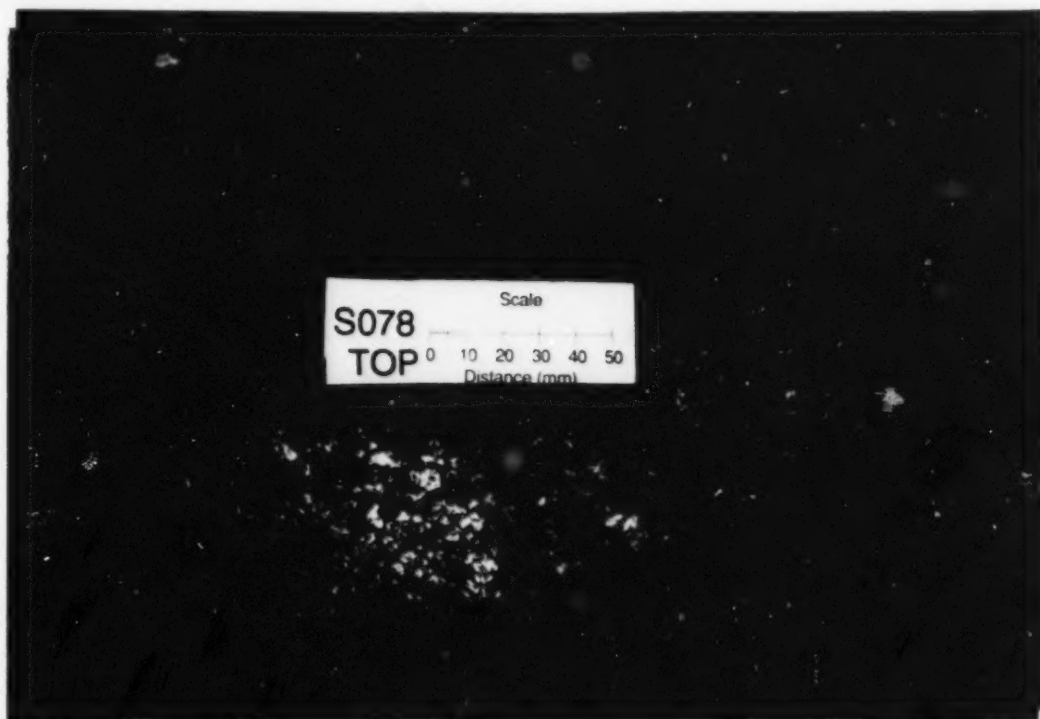


Photo No. 7: Top of Sample No. S078 Following Testing, Showing Hole Through Sample in Potash Rock.

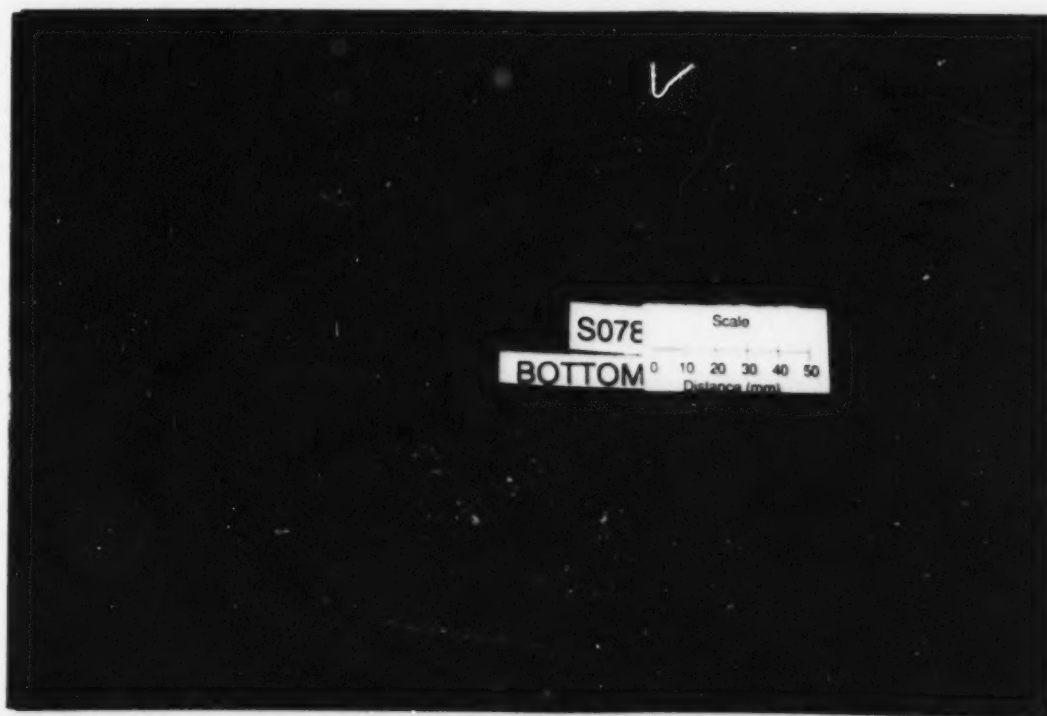


Photo No. 8: Bottom of Sample No. S078 Following Testing, Showing Hole Through Sample near Contact with Clay Seam.

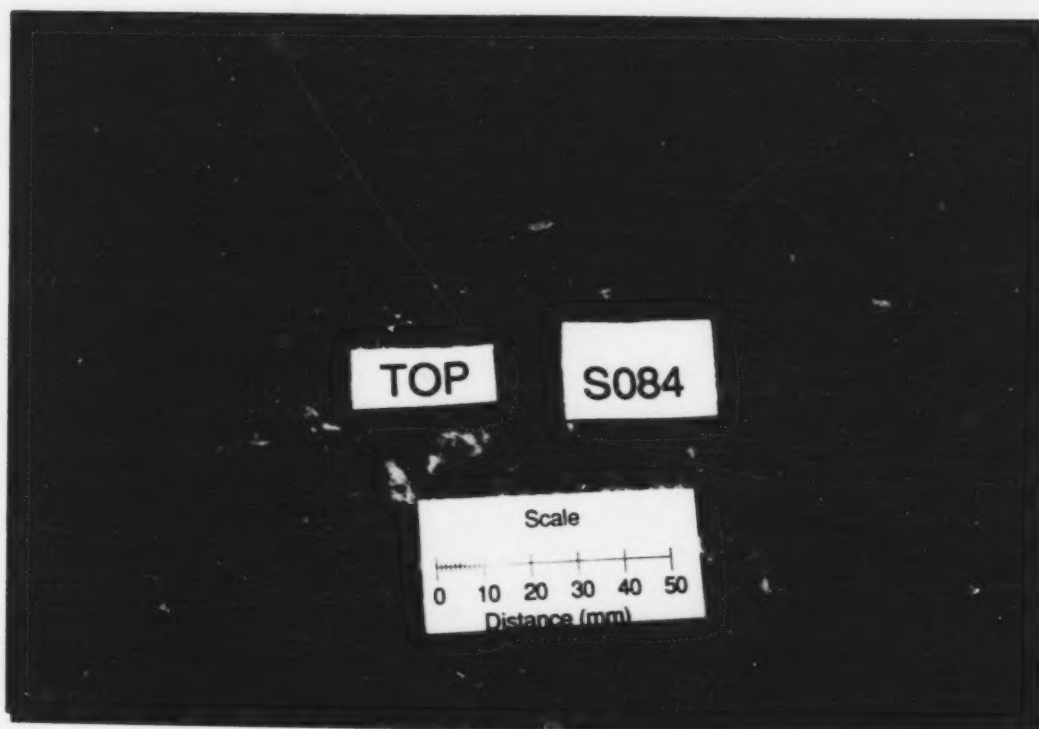


Photo No. 9: Top of Sample No. S084 Following Testing, Showing Hole Through Sample in Potash Rock.



Photo No. 10: Bottom of Sample No. S084 Following Testing, Showing Hole Through Sample near Contact with Clay Seam.

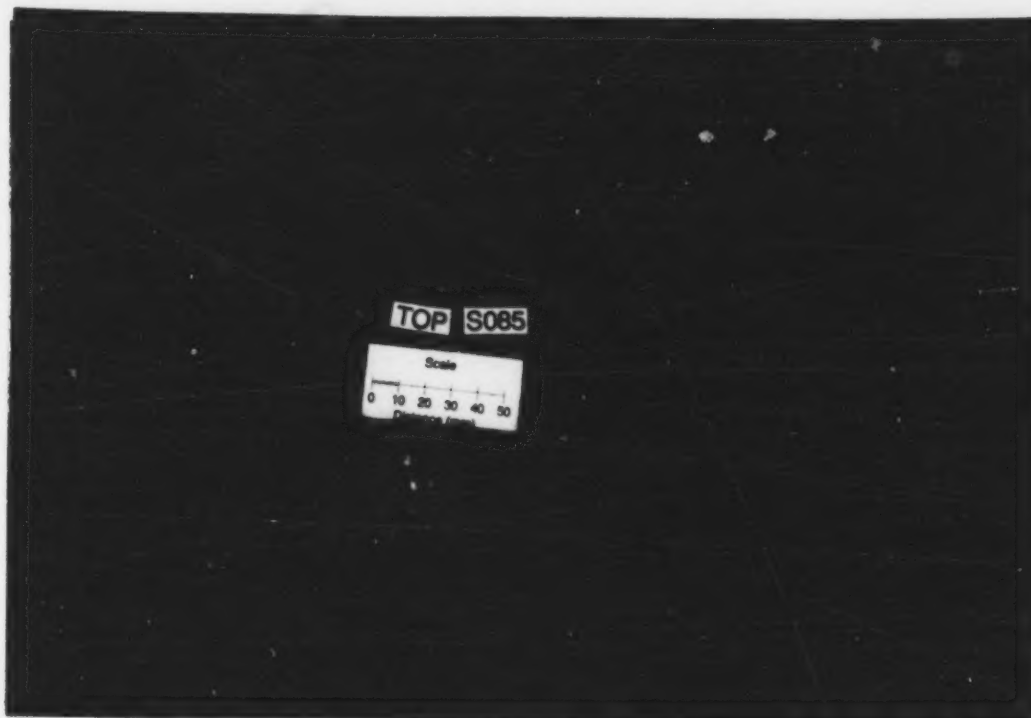


Photo No. 11: Top of Sample No. S085 Following Testing, Showing Precipitated NaCl.

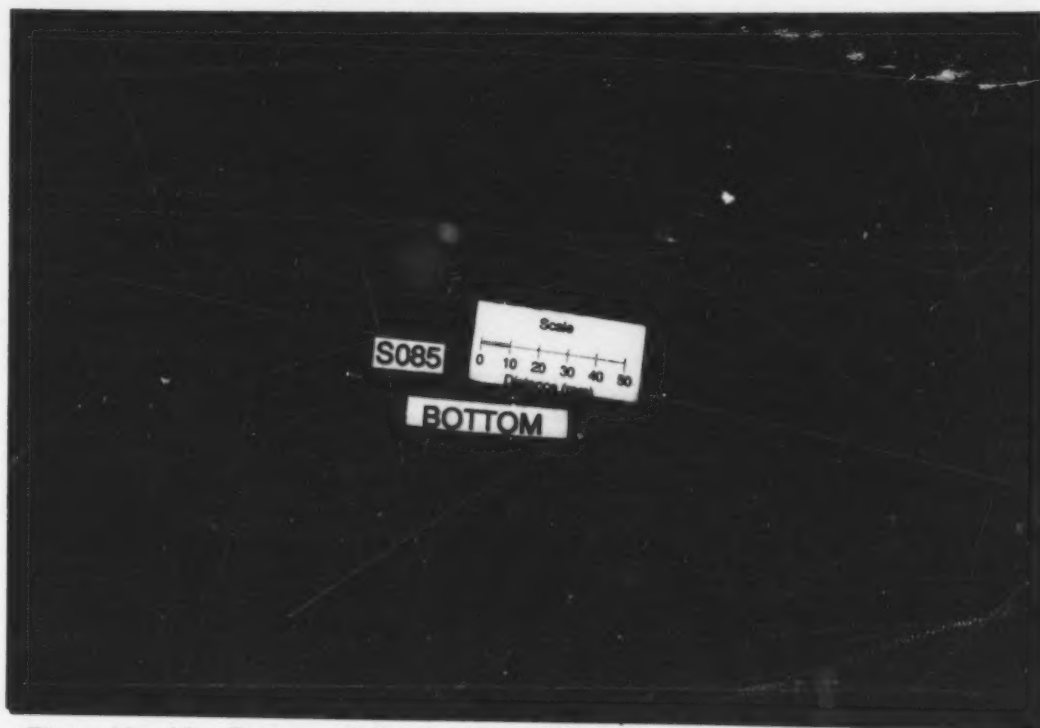


Photo No. 12: Bottom of Sample No. S085 Following Testing, Showing Apparent Selective Solutioning of Potash Rock.

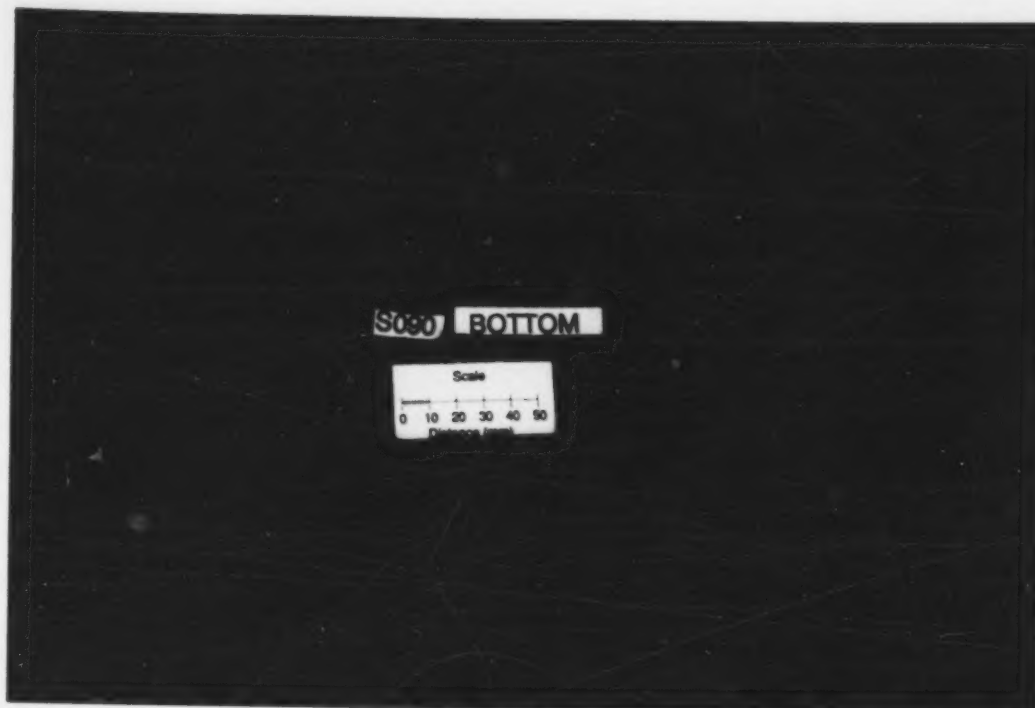


Photo No. 13: Bottom of Failed Sample No. S090 Following Testing.

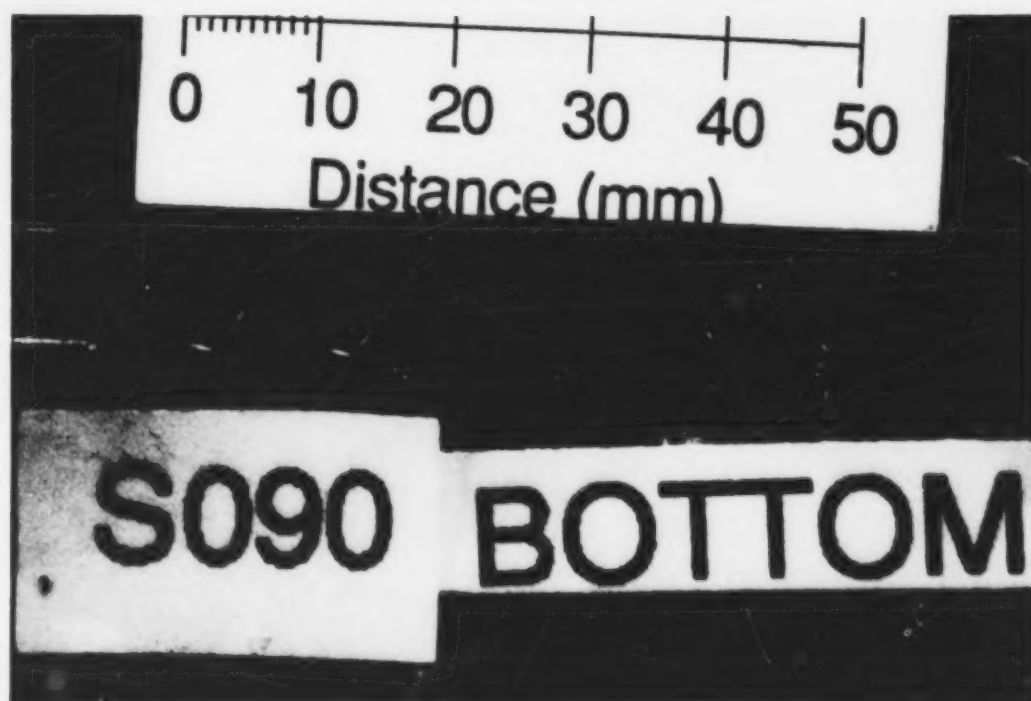


Photo No. 14 Bottom of Sample No. S090 Showing Location of Failure



Photo No. 15: Top of Sample No. S108 Following Testing Showing Little Apparent Dissolution.



Photo No. 16: Bottom of Sample No. S108 Showing Deep Dissolution in the Potash Rock Along the Contact With the Clay Seam

APPENDIX

CLAY SEAM TEST DATA

TRIAXIAL
PERMEABILITY/VOLUME CHANGE
TEST RESULTS

TEST NO: 9066

ELAPSED TIME:

BOTTOM

TOP

DATE	HOUR	MIN	ELAPSED TIME (min.)	BURET CODE	BOT. READING (ml)	BOT. PRESS. (kPa)	BOT. PRESS. (psi)	BURET CODE	TOP READING (ml)	TOP PRESS. (kPa)	TOP PRESS. (psi)
11-May-89	11	56	0	R	17.25	419.76	60.86	R	14.35	71.018	10.3
11-May-89	11	57	1	R	17.36	419.83	60.89	R	15.04	72.259	10.48
11-May-89	11	55	2	R	17.49	419.49	60.84	R	15.27	72.052	10.45
11-May-89	12	0	4	R	17.6	419.83	60.89	R	15.44	72.742	10.55
11-May-89	12	5	9	R	17.89	419.62	60.86	R	15.5	72.949	10.58
11-May-89	12	11	15	R	18.34	419.56	60.85	R	15.58	72.742	10.55
11-May-89	12	47	51	R	19.23	418.80	60.74	R	15.76	72.604	10.53
11-May-89	13	48	112	R	21.26	418.59	60.71	R	15.94	73.155	10.61
11-May-89	14	51	175	R	22.38	418.45	60.69	R	16.12	72.949	10.58
11-May-89	15	39	223	R	23.09	418.18	60.65	R	16.24	72.880	10.57
11-May-89	16	53	297	R	24.06	418.18	60.65	R	16.48	72.949	10.58

LEGENDS

ELAPSED TIME:

BURET CODE:

BOTTOM:

TOP:

BOT. PRESS.:

TOP PRESS.:

Time from start of test in minutes.
Indicates the burette that was used to
record the reading
(R=RIGHT BURETTE, L=LEFT BURETTE).
Bottom of sample.
Top of sample.
Pressure applied to the bottom of the
sample.
Pressure applied to the top of the
sample.

TEST NO: S066

SPREADSHEET CALCULATIONS

AREA= 324.29354 (sq. cm)		BOTTOM				TOP		
HYDRAULIC GRADIENT	CHANGE IN TIME (min)	CHANGE IN FLOW (ml)	CUM. FLOW (ml)	APP. PERM. (cm/sec.)	CHANGE IN FLOW (ml)	CUM. FLOW (ml)	APP. PERM. (cm/sec.)	
592.8734	0	0.000	0	0.0E+00	0.000	0	0.0E+00	
591.8771	1	0.110	0.11	9.6E-09	-0.690	-0.69	*****	
590.7636	1	0.130	0.24	1.1E-08	-0.230	-0.92	*****	
590.3533	2	0.110	0.35	4.8E-09	-0.170	-1.09	*****	
589.7086	5	0.290	0.64	5.1E-09	-0.060	-1.15	*****	
589.4742	6	0.450	1.09	6.5E-09	-0.080	-1.23	*****	
589.0639	35	0.390	1.98	2.2E-09	-0.180	-1.41	*****	
587.8918	61	2.030	4.01	2.9E-09	-0.180	-1.59	*****	
587.5057	63	1.120	5.13	1.6E-09	-0.180	-1.77	*****	
587.1885	48	0.710	5.84	1.3E-09	-0.120	-1.89	*****	
586.9541	74	0.970	6.81	1.1E-09	-0.240	-2.13	*****	

LEGENDS

AREA: Cross sectional area of the sample.

HYDRAULIC GRADIENT: The ratio of difference in fluid pressure across the sample (measure in units of length) to the thickness of the sample.

CHANGE IN TIME: Time between the previous reading and the present reading.

CHANGE IN FLOW: The amount of fluid flow through the sample between two readings.

CUM. FLOW: Total amount of fluid flow through the sample.

APP. PERM.: The sum of rate of change in volume due to chemical dissolution and the actual permeability of the sample.

3-5-50 TIME:

2508

100

DATE	TIME	WIND	TEMP	REL	WIND	TEMP	REL	WIND	TEMP	REL	WIND	TEMP	REL
1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
25-JUL-65	11	10	8	8	0.00	100.00	74.1	-	21.35	87.100	9.04		
26-JUL-65	11	10	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
27-JUL-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
28-JUL-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
29-JUL-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
30-JUL-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
31-JUL-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
1-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
2-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
3-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
4-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
5-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
6-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
7-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
8-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
9-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
10-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
11-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
12-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
13-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
14-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
15-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
16-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
17-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
18-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
19-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
20-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
21-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
22-AUG-65	11	11	9	9	0.00	100.00	74.1	-	21.35	87.100	9.04		
23-AUG-65	11	11											

EST NO: 8084

SPREADSHEET CALCULATIONS

AREA= 515.70278		BOTTOM			TOP		
SEC. CR.							
HYDRAULIC GRADIENT	CHANGE IN TIME (min)	CHANGE IN FLOW (cfs)	CUM. FLOW (cfs)	APP. PERM. (cm/sec.)	CHANGE IN FLOW (cfs)	CUM. FLOW (cfs)	APP. PERM. (cm/sec.)
442.1888	0	0.000	0.00	0.0E+00	0.000	0.00	0.0E+00
442.6703	1	0.320	0.32	3.3E-08	0.200	0.2	1.4E-08
442.8221	1	0.260	0.58	3.1E-08	0.150	0.35	1.5E-08
442.8397	2	0.370	0.95	1.2E-08	0.340	0.69	2.0E-08
442.1572	4	0.870	1.82	2.6E-08	0.700	1.39	2.1E-08
441.8913	7	1.260	3.08	2.1E-08	1.040	2.43	1.3E-08
439.9268	18	2.610	5.69	1.2E-08	2.430	4.86	1.5E-08
437.1730	30	4.090	9.78	1.6E-08	3.590	8.45	1.5E-08
430.6423	40	4.940	14.72	1.3E-08	4.550	13.1	1.4E-08
438.7433	0	0.000	14.72	1.3E-08	0.000	13.1	1.4E-08
439.4448	112	10.120	25.04	1.2E-08	9.540	23.64	1.2E-08
437.1024	164	0.000	25.04	1.0E-08	0.000	23.64	1.0E-08
438.8148	161	8.760	33.82	7.2E-09	10.140	33.16	8.0E-09
439.9975	646	0.000	33.82	7.2E-09	0.000	33.16	8.0E-09
434.2550	400	16.370	50.19	4.9E-09	16.370	49.55	4.3E-09

EST NO: 5025

ELAPSED TIME:

BOTTOM

TOP

DATE	HOUR	MIN	ELAPSED TIME (MIN.)	BURST CODE	DEPTH (M)	BURST PRESS. (KPa)	DEPTH (M)	BURST PRESS. (KPa)	DEPTH (M)	BURST PRESS. (KPa)	DEPTH (M)	BURST PRESS. (KPa)
28-Jul-88	10	33	0	L	3.1	233.73	4.18	L	15.06	69.087	10.01	
28-Jul-88	10	34	1	L	4.18	235.10	41.08	L	15.08	69.55	10.01	
28-Jul-88	10	35	2	L	4.43	235.31	41.08	L	15.09	69.422	10.07	
28-Jul-88	10	37	4	L	4.6	235.24	41.07	L	14.94	69.225	10.04	
28-Jul-88	10	41	8	L	5.68	234.81	41.01	L	14.94	69.234	10.05	
28-Jul-88	11	0	15	L	7.4	234.63	41.23	L	10.81	69.51	10.05	
28-Jul-88	11	33	30	L	11.14	234.34	41.24	L	10.08	69.839	10.1	
28-Jul-88	13	27	154	L	26.6	231.34	40.76	L	-2	70.504	10.24	
28-Jul-88	13	41	168	R	1.11	235.65	41.43	L	22.4	66.505	9.65	
28-Jul-88	17	4	371	R	6.82	235.02	41.34	R	22.4	66.535	9.65	

TEST NO: 8085

SPREADSHEET CALCULATIONS

AREA= 315.73276		BOTTOM			TOP		
(SQ. IN)							
	CHANGE	CHANGE	CUM.	APP.	CHANGE	CUM.	APP.
HYDRAULIC IN TIME	IN FLOW	IN FLOW	FLOW	PERM.	IN FLOW	FLOW	PERM.
GRADIENT	(in)	(in)	(in)	(cm/sec)	(in)	(in)	(cm/sec)
=====	=====	=====	=====	=====	=====	=====	=====
445.5040	0	0.000	0	0.0E+00	0.000	0	0.0E+00
449.8002	1	0.750	0.75	3.3E-08	0.010	0.01	3.3E-08
451.0145	1	0.500	1.00	3.3E-08	0.060	0.67	4.2E-08
451.0355	1	0.450	1.75	1.3E-08	0.450	1.12	2.3E-08
450.7354	4	0.350	2.10	2.8E-08	0.900	2.02	2.9E-08
443.5712	7	1.550	4	2.3E-08	1.220	3.24	3.3E-08
443.0051	15	2.740	6.74	2.1E-08	2.740	5.98	2.1E-08
444.0091	124	15.150	22.9	1.5E-08	12.060	18.05	1.2E-08
445.5750	14	0.000	22.9	1.5E-08	0.000	18.05	1.2E-08
457.0015	203	5.710	28.61	3.8E-08	0.000	18.05	4.0E-08

TEST NO. 13

ELAPSED TIME:

BOT/OT

TOP

DATE	HOUR	MIN	ELAPSED TIME (min.)	BURST CODE	BURST READING (ksi)	BOT. PRESS. (ksi)	BOT. PRESS. (psi)	BURST CODE	TOP READING (ksi)	TOP PRESS. (psi)
22-Nov-89	11	8	0	L	2.31 420.21	61.09	R	20.34 74.348	10.87	
22-Nov-89	11	11	2	L	2.14 420.96	61.05	R	20.6 74.741	10.94	
22-Nov-89	11	13	4	L	2.75 420.87	61.04	R	20.56 74.186	10.76	
22-Nov-89	11	17	8	L	2.55 421.07	61.07	R	20.76 73.381	10.84	
22-Nov-89	11	24	15	L	3.13 420.90	61.00	R	21 72.343	10.83	
22-Nov-89	11	33	24	L	2.75 420.43	61.05	R	21.04 71.643	10.71	
22-Nov-89	12	25	37	L	3.33 420.53	61.05	R	21.34 71.645	10.42	
22-Nov-89	12	25	37	L	2.55 418.31	60.59	L	17.51 75.585	10.96	
22-Nov-89	12	3	120	L	3.75 420.31	60.56	L	17.53 75.500	10.38	
22-Nov-89	12	16	257	L	4.56 420.31	60.56	L	17.45 75.707	10.58	
22-Nov-89	17	13	364	L	4.74 420.25	60.55	L	17.31 75.051	10.00	
22-Nov-89	17	13	364	L	4.74 420.11	60.42	R	16.65 73.224	10.61	
22-Nov-89	20	25	556	L	5.31 419.76	60.58	R	16.43 73.155	10.51	
23-Nov-89	6	38	1209	L	9.72 418.00	60.77	R	16.18 73.293	10.63	
23-Nov-89	14	12	1623	L	10.96 418.51	60.7	R	16.08 73.638	10.63	
23-Nov-89	19	28	1933	L	12.15 418.45	60.69	R	16.74 73.500	10.66	
24-Nov-89	6	48	2737	L	13.3 417.63	60.57	R	16.22 73.914	10.72	
24-Nov-89	16	56	3226	L	19.52 416.73	60.44	R	16.06 74.346	10.87	
24-Nov-89	16	55	3226	R	0.51 420.25	60.95	R	18.06 74.741	10.34	
27-Nov-89	6	35	7046	R	15.66 417.53	60.37	R	16.74 75.056	10.89	
27-Nov-89	16	53	7546	R	17.2 417.21	60.51	R	16.46 75.224	10.91	
27-Nov-89	16	53	7546	L	2.64 419.69	60.67	R	16.46 75.155	10.9	
28-Nov-89	6	47	8431	L	5.16 419.35	60.32	R	16.04 75.381	10.92	
28-Nov-89	6	37	8928	L	6.7 418.73	60.73	R	15.55 75.381	10.83	
30-Nov-89	11	16	11527	L	12.45 417.90	60.61	R	14.35 75.431	10.94	
01-Dec-89	6	45	12516	L	15.1 417.49	60.55	R	14.42 75.224	10.91	
01-Dec-89	17	52	13363	L	16.08 416.80	60.45	R	14.2 75.155	10.9	
01-Dec-89	17	52	13363	R	3.35 419.63	60.89	R	14.1 75.431	10.94	
04-Dec-89	3	53	17144	R	10.75 416.52	60.7	R	11.92 75.913	11.01	
05-Dec-89	6	44	18875	R	11.67 417.76	60.55	R	11.12 75.569	10.96	
06-Dec-89	6	47	20016	R	12.3 417.53	60.6	R	10.33 76.259	11.08	
07-Dec-89	10	11	21542	R	13.45 417.56	60.56	R	9.35 76.465	11.05	
08-Dec-89	6	54	22905	R	14.3 417.69	60.52	R	8.64 77.135	11.13	
11-Dec-89	6	35	27115	R	17.05 416.38	60.29	R	7.05 78.158	11.35	
11-Dec-89	6	35	27206	L	1.54 419.43	60.64	R	7.05 78.259	11.35	
12-Dec-89	6	37	28646	L	2.1 419.21	60.6	R	5.9 79.223	11.49	
13-Dec-89	6	39	30110	L	3.02 419.14	60.79	R	5.29 79.292	11.5	
14-Dec-89	9	19	31570	L	2.95 418.73	60.73	R	4.1 79.499	11.53	
15-Dec-89	6	39	32970	L	4.8 418.18	60.65	R	3.9 79.085	11.47	
18-Dec-89	6	50	37301	L	7.4 417.69	60.58	R	2.62 78.809	11.40	
19-Dec-89	6	58	38749	L	8.26 418.04	60.53	R	2.12 79.035	11.47	
20-Dec-89	6	32	40163	R	2.14 417.69	60.58	A	9.2 79.154	11.48	
20-Dec-89	6	32	40163	R	17.4 417.28	60.52	A	9.2 82.188	11.92	
21-Dec-89	16	53	42104	L	10.42 417.35	60.53	L	16.35 76.465	11.09	
21-Dec-89	16	53	42104	L	11.15 417.00	60.46	L	16.35 76.879	11.15	
26-Dec-89	13	47	51998	L	16.75 416.36	60.39	L	16.32 76.465	11.09	
28-Dec-89	13	47	51998	R	0.95 419.42	60.93	L	16.32 76.534	11.1	
29-Dec-89	10	7	53218	R	1.47 419.00	60.77	L	16.32 76.120	11.04	
30-Dec-89	11	5	54716	R	2.13 418.94	60.76	L	16.35 75.603	11.11	
03-Jan-90	6	51	60342	R	5.55 418.66	60.72	L	16.4 76.348	11.16	

04-08-70	14	40	01102	3	01102	01102	01102	01102	01102
05-08-70	15	41	01103	3	01103	01103	01103	01103	01103
06-08-70	16	42	01104	3	01104	01104	01104	01104	01104
07-08-70	17	43	01105	3	01105	01105	01105	01105	01105
08-08-70	18	44	01106	3	01106	01106	01106	01106	01106
09-08-70	19	45	01107	3	01107	01107	01107	01107	01107
10-08-70	20	46	01108	3	01108	01108	01108	01108	01108
11-08-70	21	47	01109	3	01109	01109	01109	01109	01109
12-08-70	22	48	01110	3	01110	01110	01110	01110	01110
01-09-70	23	49	01111	3	01111	01111	01111	01111	01111
02-09-70	24	50	01112	3	01112	01112	01112	01112	01112
03-09-70	25	51	01113	3	01113	01113	01113	01113	01113
04-09-70	26	52	01114	3	01114	01114	01114	01114	01114
05-09-70	27	53	01115	3	01115	01115	01115	01115	01115
06-09-70	28	54	01116	3	01116	01116	01116	01116	01116
07-09-70	29	55	01117	3	01117	01117	01117	01117	01117
08-09-70	30	56	01118	3	01118	01118	01118	01118	01118
09-09-70	31	57	01119	3	01119	01119	01119	01119	01119
10-09-70	32	58	01120	3	01120	01120	01120	01120	01120
11-09-70	33	59	01121	3	01121	01121	01121	01121	01121
12-09-70	34	60	01122	3	01122	01122	01122	01122	01122
01-10-70	35	61	01123	3	01123	01123	01123	01123	01123
02-10-70	36	62	01124	3	01124	01124	01124	01124	01124
03-10-70	37	63	01125	3	01125	01125	01125	01125	01125
04-10-70	38	64	01126	3	01126	01126	01126	01126	01126
05-10-70	39	65	01127	3	01127	01127	01127	01127	01127
06-10-70	40	66	01128	3	01128	01128	01128	01128	01128
07-10-70	41	67	01129	3	01129	01129	01129	01129	01129
08-10-70	42	68	01130	3	01130	01130	01130	01130	01130
09-10-70	43	69	01131	3	01131	01131	01131	01131	01131
10-10-70	44	70	01132	3	01132	01132	01132	01132	01132
11-10-70	45	71	01133	3	01133	01133	01133	01133	01133
12-10-70	46	72	01134	3	01134	01134	01134	01134	01134
01-11-70	47	73	01135	3	01135	01135	01135	01135	01135
02-11-70	48	74	01136	3	01136	01136	01136	01136	01136
03-11-70	49	75	01137	3	01137	01137	01137	01137	01137
04-11-70	50	76	01138	3	01138	01138	01138	01138	01138
05-11-70	51	77	01139	3	01139	01139	01139	01139	01139
06-11-70	52	78	01140	3	01140	01140	01140	01140	01140
07-11-70	53	79	01141	3	01141	01141	01141	01141	01141
08-11-70	54	80	01142	3	01142	01142	01142	01142	01142
09-11-70	55	81	01143	3	01143	01143	01143	01143	01143
10-11-70	56	82	01144	3	01144	01144	01144	01144	01144
11-11-70	57	83	01145	3	01145	01145	01145	01145	01145
12-11-70	58	84	01146	3	01146	01146	01146	01146	01146
01-12-70	59	85	01147	3	01147	01147	01147	01147	01147
02-12-70	60	86	01148	3	01148	01148	01148	01148	01148
03-12-70	61	87	01149	3	01149	01149	01149	01149	01149
04-12-70	62	88	01150	3	01150	01150	01150	01150	01150
05-12-70	63	89	01151	3	01151	01151	01151	01151	01151
06-12-70	64	90	01152	3	01152	01152	01152	01152	01152
07-12-70	65	91	01153	3	01153	01153	01153	01153	01153
08-12-70	66	92	01154	3	01154	01154	01154	01154	01154
09-12-70	67	93	01155	3	01155	01155	01155	01155	01155
10-12-70	68	94	01156	3	01156	01156	01156	01156	01156
11-12-70	69	95	01157	3	01157	01157	01157	01157	01157
12-12-70	70	96	01158	3	01158	01158	01158	01158	01158
01-01-71	71	97	01159	3	01159	01159	01159	01159	01159
02-01-71	72	98	01160	3	01160	01160	01160	01160	01160
03-01-71	73	99	01161	3	01161	01161	01161	01161	01161
04-01-71	74	100	01162	3	01162	01162	01162	01162	01162
05-01-71	75	101	01163	3	01163	01163	01163	01163	01163
06-01-71	76	102	01164	3	01164	01164	01164	01164	01164
07-01-71	77	103	01165	3	01165	01165	01165	01165	01165
08-01-71	78	104	01166	3	01166	01166	01166	01166	01166
09-01-71	79	105	01167	3	01167	01167	01167	01167	01167
10-01-71	80	106	01168	3	01168	01168	01168	01168	01168
11-01-71	81	107	01169	3	01169	01169	01169	01169	01169
12-01-71	82	108	01170	3	01170	01170	01170	01170	01170
01-02-71	83	109	01171	3	01171	01171	01171	01171	01171
02-02-71	84	110	01172	3	01172	01172	01172	01172	01172
03-02-71	85	111	01173	3	01173	01173	01173	01173	01173
04-02-71	86	112	01174	3	01174	01174	01174	01174	01174
05-02-71	87	113	01175	3	01175	01175	01175	01175	01175
06-02-71	88	114	01176	3	01176	01176	01176	01176	01176
07-02-71	89	115	01177	3	01177	01177	01177	01177	01177
08-02-71	90	116	01178	3	01178	01178	01178	01178	01178
09-02-71	91	117	01179	3	01179	01179	01179	01179	01179
10-02-71	92	118	01180	3	01180	01180	01180	01180	01180
11-02-71	93	119	01181	3	01181	01181	01181	01181	01181
12-02-71	94	120	01182	3	01182	01182	01182	01182	01182
01-03-71	95	121	01183	3	01183	01183	01183	01183	01183
02-03-71	96	122	01184	3	01184	01184	01184	01184	01184
03-03-71	97	123	01185	3	01185	01185	01185	01185	01185
04-03-71	98	124	01186	3	01186	01186	01186	01186	01186
05-03-71	99	125	01187	3	01187	01187	01187	01187	01187
06-03-71	100	126	01188	3	01188	01188	01188	01188	01188
07-03-71	101	127	01189	3	01189	01189	01189	01189	01189
08-03-71	102	128	01190	3	01190	01190	01190	01190	01190
09-03-71	103	129	01191	3	01191	01191	01191	01191	01191
10-03-71	104	130	01192	3	01192	01192	01192	01192	01192
11-03-71	105	131	01193	3	01193	01193	01193	01193	01193
12-03-71	106	132	01194	3	01194	01194	01194	01194	01194
01-04-71	107	133	01195	3	01195	01195	01195	01195	01195
02-04-71	108	134	01196	3	01196	01196	01196	01196	01196
03-04-71	109	135	01197	3	01197	01197	01197	01197	01197
04-04-71	110	136	01198	3	01198	01198	01198	01198	01198
05-04-71	111	137	01199	3	01199	01199	01199	01199	01199
06-04-71	112	138	01200	3	01200	01200	01200	01200	01200
07-04-71	113	139	01201	3	01201	01201	01201	01201	01201
08-04-71	114	140	01202	3	01202	01202	01202	01202	01202
09-04-71	115	141	01203	3	01203	01203	01203	01203	01203
10-04-71	116	142	01204	3	01204	01204	01204	01204	01204
11-04-71	117	143	01205	3	01205	01205	01205	01205	01205
12-04-71	118	144	01206	3	01206	01206	01206	01206	01206
01-05-71	119	145	01207	3	01207	01207	01207	01207	01207
02-05-71	120	146	01208	3	01208	01208	01208	01208	01208
03-05-71	121	147	01209	3	01209	01209	01209	01209	01209
04-05-71	122	148	01210	3	01210	01210	01210	01210	01210
05-05-71	123	149	01211	3	01211	01211	01211	01211	01211
06-05-71	124	150	01212	3	01212	01212	01212	01212	01212
07-05-71	125	151	01213	3	01213				

TEST NO: 5016 SPARE405-117 CALCULATIONS

HEAD= 324.16354		30' DM			10'		
(SEC. CM)							
	CHANGE	CHANGE	CLM.	APP.	CHANGE	CLM.	APP.
HYDRAULIC IN TIME	IN TIME	IN FLOW	FLOW	PERK.	IN FLOW	FLOW	PERK.
SPARE405-117	(MIN)	(G)	(G)	(G/SEC)	(G)	(G)	(G/SEC)
=====							
581.3352	0	0.000	0.000	0.00E+00	0.000	0.00E+00	
581.7704	2	-0.070	-0.07	*****	-0.070	-0.07	*****
581.7777	1	0.610	0.61	1.3E-08	-5.960	-5.96	*****
1001.8711	4	0.200	0.64	3.8E-09	3.800	-0.42	1.1E-07
111.8111	7	0.180	0.82	1.9E-08	-0.140	-0.68	*****
586.1829	15	-0.180	0.84	*****	-0.040	-0.7	*****
537.4048	47	0.400	1.04	6.4E-10	-0.500	-1.2	*****
577.2221	0	0.000	1.04	6.4E-10	0.000	-1.2	*****
678.0132	-6	0.400	1.44	7.1E-10	-0.550	-1.78	*****
678.7534	137	0.830	2.27	4.6E-10	-0.400	-2.18	*****
578.1725	107	0.160	2.43	1.1E-10	0.160	-2	1.3E-10
580.4127	0	0.000	2.43	1.1E-10	0.000	-2	1.3E-10
582.7896	192	1.070	3.5	4.2E-10	0.200	-1.8	7.6E-11
581.6346	750	3.910	7.41	3.9E-10	0.170	-1.83	1.7E-11
579.6375	314	1.240	6.65	3.9E-10	0.220	-1.41	5.0E-11
579.1907	313	1.130	9.84	1.9E-10	0.320	-2.09	7.7E-11
578.0367	738	3.150	12.59	3.0E-10	0.620	-0.87	4.9E-11
574.9140	439	4.220	17.21	5.6E-10	0.160	-0.41	2.3E-11
576.6730	0	0.000	17.21	5.6E-10	0.000	-0.41	2.3E-11
577.4257	3620	15.150	32.38	3.7E-10	1.320	0.31	2.6E-11
578.9638	500	1.540	35.8	2.3E-10	1.260	1.07	4.0E-11
575.9322	0	0.000	35.8	2.3E-10	0.000	1.07	4.0E-11
577.5009	582	2.540	38.44	2.3E-10	0.440	1.61	3.5E-11
576.7469	1430	3.820	38.98	1.3E-10	0.490	2.0	2.6E-11
578.2514	1599	3.750	48.71	1.6E-10	0.500	2.7	2.9E-11
574.1572	1289	2.650	48.38	1.6E-10	0.530	3.13	3.1E-11
578.3526	547	0.950	47.34	1.4E-10	0.220	3.45	3.1E-11
575.4370	0	0.000	47.34	1.4E-10	0.000	3.45	3.1E-11
576.4074	3761	7.400	54.74	1.5E-10	2.280	5.73	4.6E-11
574.2351	1431	1.120	55.86	6.0E-11	0.800	6.53	4.3E-11
573.2165	1443	0.330	55.19	1.7E-11	0.730	7.18	3.6E-11
572.1307	1524	1.250	57.44	6.3E-11	1.040	8.3	5.2E-11
571.1124	1353	0.850	58.29	4.8E-11	0.710	9.01	4.0E-11
568.1953	4301	2.750	61.04	4.9E-11	1.590	10.6	2.8E-11
568.6722	0	0.000	61.04	4.9E-11	0.800	10.6	2.8E-11
570.7051	1442	0.550	61.6	3.0E-11	1.150	11.75	6.1E-11
569.3474	1462	0.920	62.52	4.8E-11	0.610	12.38	3.7E-11
568.5006	1480	0.930	63.45	4.9E-11	1.190	13.55	6.3E-11
567.8539	1400	0.850	64.3	4.7E-11	0.300	13.85	1.6E-11
567.5145	4331	2.600	66.9	4.6E-11	1.150	15.03	2.1E-11
567.3787	1446	0.260	67.76	4.6E-11	0.500	15.53	2.7E-11
567.0393	1414	0.000	67.76	4.6E-11	0.000	15.53	2.7E-11
566.2377	0	0.000	67.76	4.6E-11	0.000	15.53	2.7E-11
565.5458	1941	0.000	67.76	4.6E-11	0.000	15.53	2.7E-11
570.5014	0	0.000	67.76	4.6E-11	0.000	15.53	2.7E-11
569.5510	5694	5.600	73.36	4.3E-11	0.030	15.56	2.3E-13
572.2654	0	0.000	73.36	4.3E-11	0.000	15.56	2.3E-13
575.1855	1220	0.520	73.89	3.2E-11	0.000	15.58	0.9E+00
574.8424	1413	0.710	74.59	3.5E-11	-0.030	15.50	*****
573.4984	5615	3.370	77.52	4.6E-11	-0.050	15.48	*****

071.1207	1097	0.510	75.51 3.02E-11	0.000	15.46 0.02E+00
071.1208	1084	0.740	75.51 3.02E-11	0.000	15.46 0.02E+00
071.1262	4811	1.500	82.11 4.16E-11	0.000	15.46 0.02E+00
071.1243	580	15.150	87.38 3.02E-11	0.000	15.46 0.02E+00
071.1401	0	0.000	87.38 3.02E-11	0.000	15.46 0.02E+00
071.1401	1154	0.550	87.38 3.02E-11	0.000	15.46 0.02E+00
071.1124	1087	0.220	86.18 1.50E-11	0.000	15.46 0.02E+00
071.1262	1442	0.510	86.18 1.50E-11	0.000	15.46 0.02E+00
071.1262	87	0.510	86.18 1.50E-11	0.000	15.46 0.02E+00
071.1262	0	0.000	86.18 1.50E-11	0.000	15.46 0.02E+00

TEST NO: 8121

ELAPSED TIME:

BOTTOM

TOP

DATE	HR	MIN	ELAPSED TIME (MIN)	SUPET CODE	SCF. READING (KPa)	SCF. PRESS. (KPa)	SCF. CODE	SUPET READING (KPa)	TOP PRESS. (KPa)	TOP PRESS. (KPa)	
08-Feb-90	10	41	0	R	12.82	414.25	60.06	L	9.7	70.465	10.21
08-Feb-90	10	42	1	R	12.67	414.52	60.12	L	9.4	70.373	10.25
08-Feb-90	10	43	2	R	12.65	414.45	60.11	L	9.23	70.311	10.27
08-Feb-90	10	45	4	R	12.83	415.65	60.21	L	9.54	70.357	10.21
08-Feb-90	10	46	5	R	12.45	414.25	60.3	L	9.45	70.343	10.19
08-Feb-90	10	55	15	R	13.02	414.32	60.31	L	9.44	70.345	10.29
08-Feb-90	11	11	30	R	14.13	413.37	60.04	L	9.33	71.087	10.31
08-Feb-90	12	6	140	R	15.44	413.41	60.36	L	8.82	71.353	10.44
08-Feb-90	13	6	145	L	1.7	413.63	60.28	R	15.34	71.570	10.38
08-Feb-90	14	40	213	L	4.85	415.01	60.11	R	14.50	71.570	10.38
09-Feb-90	8	55	1332	L	11.81	414.04	60.05	R	10.45	72.253	10.31
11-Feb-90	10	0	4274	L	22.65	411.83	59.71	R	6.5	74.334	10.61
11-Feb-90	10	0	4275	R	0.35	417.43	60.35	L	15	73.121	10.48
12-Feb-90	8	15	5534	R	4.47	417.25	60.35	L	14.33	73.455	10.51
14-Feb-90	10	4	8583	R	19.3	414.45	60.11	L	12.33	73.585	10.57
14-Feb-90	16	31	9010	R	13.78	414.04	60.11	L	12.82	73.707	10.69
14-Feb-90	16	31	9010	L	11.04	417.30	60.31	L	12.52	73.133	10.63
19-Feb-90	8	55	15734	L	22.3	416.07	59.91	L	-0.05	75.253	10.92
19-Feb-90	8	55	15734	R	0.35	416.59	60.71	R	1.02	74.741	10.84
19-Feb-90	13	7	15555	R	1.5	416.15	60.55	R	1.61	75.551	10.95
19-Feb-90	16	45	18104	R	1.92	417.75	60.53	R	0.73	75.485	11.03
19-Feb-90	16	45	18204	R	1.92	417.30	60.51	L	5.5	77.637	11.23
21-Feb-90	16	21	19090	R	3.34	416.36	60.39	L	2.79	75.775	10.99
21-Feb-90	16	54	19093	R	5.45	416.11	60.35	L	2.79	76.256	11.01
21-Feb-90	16	54	19093	R	9.49	416.18	60.36	R	19.9	72.741	10.71
25-Feb-90	11	0	24499	R	17.62	414.52	60.12	R	10.9	76.575	11.15
25-Feb-90	11	0	24499	L	2.52	417.55	60.56	L	6.01	75.948	11.13
27-Feb-90	13	30	27529	L	7.6	417.49	60.55	L	5.3	74.466	10.8
27-Feb-90	13	30	27529	R	5.29	415.35	60.24	R	12.34	75.327	11.07
01-Mar-90	10	46	30245	R	12.15	415.45	60.26	R	3.29	76.455	11.05
02-Mar-90	9	0	31579	R	14.43	415.11	60.35	R	4.05	77.430	11.23
02-Mar-90	9	0	31579	L	5.51	417.30	60.51	L	14.35	75.503	11.11
11-Mar-90	12	53	44771	L	24.64	411.01	59.51	L	3.4	74.337	10.79
11-Mar-90	12	53	44772	R	1.2	416.11	60.05	R	17.58	71.570	10.38
14-Mar-90	16	0	43273	R	5.55	413.37	60.31	R	13.76	72.349	10.58
14-Mar-90	16	5	45284	R	6.74	419.35	60.52	R	13.55	72.455	10.51
15-Mar-90	13	14	53553	R	3.3	419.59	60.37	R	12.94	73.500	10.65
16-Mar-90	9	12	51751	R	11.02	415.55	60.57	R	11.51	74.121	10.75
19-Mar-90	9	29	56055	R	14.73	415.35	60.55	R	7.57	74.572	10.83
19-Mar-90	9	29	56055	R	14.75	415.35	60.55	R	7.67	74.572	10.83

NAME	DATE	TIME	FLUX	PERC.	NAME	DATE	TIME	FLUX	PERC.
701.8477	0	0.000	0.00E+00	0.000	0.00E+00	0	0.000	0.00E+00	0.000
701.8491	1	-0.150	-0.15E+00	0.300	0.30E+00	0.300	0.30E+00	0.30E+00	0.300
701.8504	1	-0.020	-0.17E+00	0.170	0.47E+00	0.47E+00	0.47E+00	0.47E+00	0.470
701.8518	2	0.040	0.13E+00	0.230	0.78E+00	0.78E+00	0.78E+00	0.78E+00	0.780
701.8532	4	-0.240	-0.37E+00	-0.810	0.23E+00	0.23E+00	0.23E+00	0.23E+00	0.230
701.8545	7	0.510	0.20E+00	0.710	0.28E+00	0.28E+00	0.28E+00	0.28E+00	0.280
701.8559	10	1.210	1.41E+00	1.430	0.38E+00	0.38E+00	0.38E+00	0.38E+00	0.380
701.8573	115	4.210	3.82E+00	3.800	0.38E+00	0.38E+00	0.38E+00	0.38E+00	0.380
701.8587	0	0.000	0.00E+00	0.000	0.38E+00	0.38E+00	0.38E+00	0.38E+00	0.380
701.8601	84	1.850	7.47E+00	1.820	4.47E+00	4.47E+00	4.47E+00	4.47E+00	4.470
701.8615	1053	3.270	15.74E+00	4.070	8.77E+00	8.77E+00	8.77E+00	8.77E+00	8.770
701.8629	1947	9.830	28.57E+00	3.950	12.72E+00	12.72E+00	12.72E+00	12.72E+00	12.720
701.8643	0	0.000	0.00E+00	0.000	16.72E+00	16.72E+00	16.72E+00	16.72E+00	16.720
701.8657	1815	3.320	19.95E+00	4.850	18.37E+00	18.37E+00	18.37E+00	18.37E+00	18.370
701.8671	3605	14.880	41.51E+00	14.707	14.707E+00	14.707E+00	14.707E+00	14.707E+00	14.7070
701.8685	547	0.450	44.37E+00	0.330	18.71E+00	18.71E+00	18.71E+00	18.71E+00	18.710
701.8699	0	0.000	44.37E+00	0.000	18.71E+00	18.71E+00	18.71E+00	18.71E+00	18.710
701.8713	6724	21.260	18.57E+00	1.570	17.77E+00	17.77E+00	17.77E+00	17.77E+00	17.770
701.8727	0	0.000	63.83E+00	0.000	27.77E+00	27.77E+00	27.77E+00	27.77E+00	27.770
701.8741	151	0.850	66.18E+00	0.000	27.77E+00	27.77E+00	27.77E+00	27.77E+00	27.770
701.8755	216	0.420	66.18E+00	0.270	26.74E+00	26.74E+00	26.74E+00	26.74E+00	26.740
701.8769	0	0.000	66.18E+00	0.000	26.74E+00	26.74E+00	26.74E+00	26.74E+00	26.740
701.8783	2736	6.420	73.92E+00	3.810	31.55E+00	31.55E+00	31.55E+00	31.55E+00	31.550
701.8797	93	0.150	73.17E+00	0.000	31.55E+00	31.55E+00	31.55E+00	31.55E+00	31.550
701.8811	0	0.000	73.17E+00	0.000	31.55E+00	31.55E+00	31.55E+00	31.55E+00	31.550
701.8825	5406	6.130	81.31E+00	3.000	40.85E+00	40.85E+00	40.85E+00	40.85E+00	40.850
701.8839	0	0.000	81.31E+00	0.000	40.85E+00	40.85E+00	40.85E+00	40.85E+00	40.850
701.8853	3030	3.060	86.38E+00	0.710	41.56E+00	41.56E+00	41.56E+00	41.56E+00	41.560
701.8867	0	0.000	86.38E+00	0.000	41.56E+00	41.56E+00	41.56E+00	41.56E+00	41.560
701.8881	2716	6.890	93.17E+00	7.050	48.51E+00	48.51E+00	48.51E+00	48.51E+00	48.510
701.8895	1334	3.310	95.58E+00	1.240	49.85E+00	49.85E+00	49.85E+00	49.85E+00	49.850
701.8909	0	0.000	95.58E+00	0.000	49.85E+00	49.85E+00	49.85E+00	49.85E+00	49.850
701.8923	13133	13							

BRINE CHEMICAL ANALYSIS

FOR

TEST NO S108

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE:

Jan. 25, 1990

SOURCE: CCP Brine, collected COLLECTION DATE: Nov. 30, 1989
 Nov. 30, 1989
 LAB NO: 1130-89L ANALYSIS DATE: Jan. 22, 1990

APPEARANCE: clear, colorless
 ODOR: H₂S
 pH= 6.3

TOTAL DISSOLVED SOLIDS mg/l umhos/cm
 By evaporation at 103°C 335,400
 By conductivity at 25°C 437,680 604,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	43,961	P. Alkalinity*	0
Calcium Hardness*	23,978	Carbonate as CO ₃	0
Magnesium Hardness*	19,982	Total Alkalinity*	14
Sodium as Na	93,916	Bicarbonate as HCO ₃	17
Potassium as K	4,596	Chloride as Cl	179,521
Iron as Fe	0.00	Nitrate as NO ₃	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO ₃		Sulfate as SO ₄	247

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

 C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY
UNIVERSITY OF SASKATCHEWAN
DEPARTMENT OF CIVIL ENGINEERING

TO: Dr. M. D. Haug REPORTING DATE: April 18, 1989

SOURCE: Brine, collected COLLECTION DATE: Jan. 8, 1990
Jan. 8, 1990
LAB NO: 0108-90L ANALYSIS DATE: Jan. 10, 1990

APPEARANCE: clear, orange
ODOR: H₂S
pH= 5.0

TOTAL DISSOLVED SOLIDS mg/l umhos/cm
By evaporation at 103°C 401,800
By conductivity at 25°C 512,000 708,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	45,209	P. Alkalinity*	0
Calcium Hardness*	28,769	Carbonate as CO ₃	0
Magnesium Hardness*	16,440	Total Alkalinity*	5
Sodium as Na	80,143	Bicarbonate as HCO ₃	6
Potassium as K	56,511	Chloride as Cl	206,721
Iron as Fe	0.00	Nitrate as NO ₃	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO ₃		Sulfate as SO ₄	0

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE:

April 18, 1989

SOURCE: Brine, collected
Jan. 11, 1990

COLLECTION DATE:

Jan. 11, 1990

LAB NO: 0111-90L

ANALYSIS DATE:

Jan. 12, 1990

APPEARANCE: clear, colorless
ODOR: H₂S
pH= 6.4

TOTAL DISSOLVED SOLIDS mg/l umhos/cm

By evaporation at 103°C 396,400

By conductivity at 25°C 501,040

692,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	47,327	P. Alkalinity*	0
Calcium Hardness*	30,865	Carbonate as CO ₃	0
Magnesium Hardness*	16,461	Total Alkalinity*	6
Sodium as Na	77,163	Bicarbonate as HCO ₃	7
Potassium as K	54,529	Chloride as Cl	201,858
Iron as Fe	0.00	Nitrate as NO ₃	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO ₃		Sulfate as SO ₄	0

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

C. D. Fisher

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE:

April 18, 1989

SOURCE: Brine, collected COLLECTION DATE: Jan. 15, 1990
 Jan. 15, 1990
 LAB NO: 0115-90L ANALYSIS DATE: Jan. 16, 1990

APPEARANCE: clear,colorless
 ODOR: H2S
 pH= 6.0

TOTAL DISSOLVED SOLIDS mg/l umhos/cm

By evaporation at 103°C 402,800

By conductivity at 25°C ~495,280

684,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	49,993	P. Alkalinity*	0
Calcium Hardness*	27,996	Carbonate as CO3	0
Magnesium Hardness*	21,997	Total Alkalinity*	14
Sodium as Na	78,988	Bicarbonate as HCO3	17
Potassium as K	55,992	Chloride as Cl	207,710
Iron as Fe	0.00	Nitrate as NO3	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO3		Sulfate as SO4	0

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO3=<0.2

REPORTED BY: _____

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE:

Feb. 4, 1990

SOURCE: Brine
Jan. 18, 1990

COLLECTION DATE:

Jan. 29, 1990

LAB NO: 0129-90L

ANALYSIS DATE:

Jan. 30, 1990

APPEARANCE: clear, colorless

ODOR: H₂S

pH= 5.4

TOTAL DISSOLVED SOLIDS mg/l

umhos/cm

By evaporation at 103°C 392,800

By conductivity at 25°C 495,200

684,000

CATIONS

mg/l

ANIONS

mg/l

Total Hardness* 48,007

Calcium Hardness* 30,005

Magnesium Hardness* 18,003

Sodium as Na 75,011

Potassium as K 54,008

Iron as Fe 0.00

Manganese as Mn 0.00

*=as CaCO₃

P. Alkalinity* 0

Carbonate as CO₃ 0

Total Alkalinity* 8

Bicarbonate as HCO₃ 10

Chloride as Cl 198,210

Nitrate as NO₃ 0.00

Fluoride as F 0.00

Sulfate as SO₄ 247

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY
UNIVERSITY OF SASKATCHEWAN
DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE:

April 18, 1989

SOURCE: Brine, collected
Jan. 18, 1990

COLLECTION DATE: Jan. 18, 1990

LAB NO: 0118-90L

ANALYSIS DATE: Jan. 18, 1990

APPEARANCE: clear, colorless

ODOR: H₂S

pH= 6.3

TOTAL DISSOLVED SOLIDS mg/l umhos/cm

By evaporation at 103°C 399,600

By conductivity at 25°C 512,000 708,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	50,304	P. Alkalinity*	0
Calcium Hardness*	30,182	Carbonate as CO ₃	0
Magnesium Hardness*	20,122	Total Alkalinity*	23
Sodium as Na	78,474	Bicarbonate as HCO ₃	28
Potassium as K	55,334	Chloride as Cl	206,425
Iron as Fe	0.00	Nitrate as NO ₃	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO ₃		Sulfate as SO ₄	164

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY
UNIVERSITY OF SASKATCHEWAN
DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE:

Jan. 25, 1990

SOURCE: Brine, collected
Jan. 22, 1990
LAB NO: 0122-90L

COLLECTION DATE: Jan. 22, 1990

ANALYSIS DATE: Jan. 22, 1990

APPEARANCE: clear, colorless
ODOR: H₂S
pH= 6.2

TOTAL DISSOLVED SOLIDS mg/l umhos/cm

By evaporation at 103°C 391,800
By conductivity at 25°C 515,440

716,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	48,546	P. Alkalinity*	0
Calcium Hardness*	28,319	Carbonate as CO ₃	0
Magnesium Hardness*	20,228	Total Alkalinity*	16
Sodium as Na	77,876	Bicarbonate as HCO ₃	19
Potassium as K	56,637	Chloride as Cl	205,344
Iron as Fe	0.00	Nitrate as NO ₃	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO ₃		Sulfate as SO ₄	326

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY

UNIVERSITY OF SASKATCHEWAN

DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE:

Feb. 9, 1990

SOURCE: Brine
Feb. 1, 1990
LAB NO: 0201-90L

COLLECTION DATE: Feb. 1, 1990

ANALYSIS DATE: Feb. 5, 1990

APPEARANCE: clear, colorless
ODOR: H₂S
pH= 5.3

TOTAL DISSOLVED SOLIDS mg/l umhos/cm
By evaporation at 103°C 390,800
By conductivity at 25°C 492,400 680,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	48,427	P. Alkalinity*	0
Calcium Hardness*	25,696	Carbonate as CO ₃	0
Magnesium Hardness*	22,731	Total Alkalinity*	8
Sodium as Na	76,099	Bicarbonate as HCO ₃	10
Potassium as K	54,356	Chloride as Cl	200,588
Iron as Fe	0.00	Nitrate as NO ₃	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO ₃		Sulfate as SO ₄	83

NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

C. D. FISHER

ENVIRONMENTAL ENGINEERING LABORATORY
UNIVERSITY OF SASKATCHEWAN
DEPARTMENT OF CIVIL ENGINEERING

TO: L. Wong

REPORTING DATE: Feb. 9, 1990

SOURCE: Brine
Feb. 1, 1990
LAB NO: 0202-90L

COLLECTION DATE: Feb. 2, 1990
ANALYSIS DATE: Feb. 5, 1990

APPEARANCE: clear, colorless
ODOR: H₂S
pH= 5.4

TOTAL DISSOLVED SOLIDS mg/l umhos/cm
By evaporation at 103°C 390,400
By conductivity at 25°C ~495,200 684,000

CATIONS	mg/l	ANIONS	mg/l
Total Hardness*	48,609	P. Alkalinity*	0
Calcium Hardness*	27,777	Carbonate as CO ₃	0
Magnesium Hardness*	20,832	Total Alkalinity*	8
Sodium as Na	75,394	Bicarbonate as HCO ₃	10
Potassium as K	54,561	Chloride as Cl	199,835
Iron as Fe	0.00	Nitrate as NO ₃	0.00
Manganese as Mn	0.00	Fluoride as F	0.00
*=as CaCO ₃		Sulfate as SO ₄	83

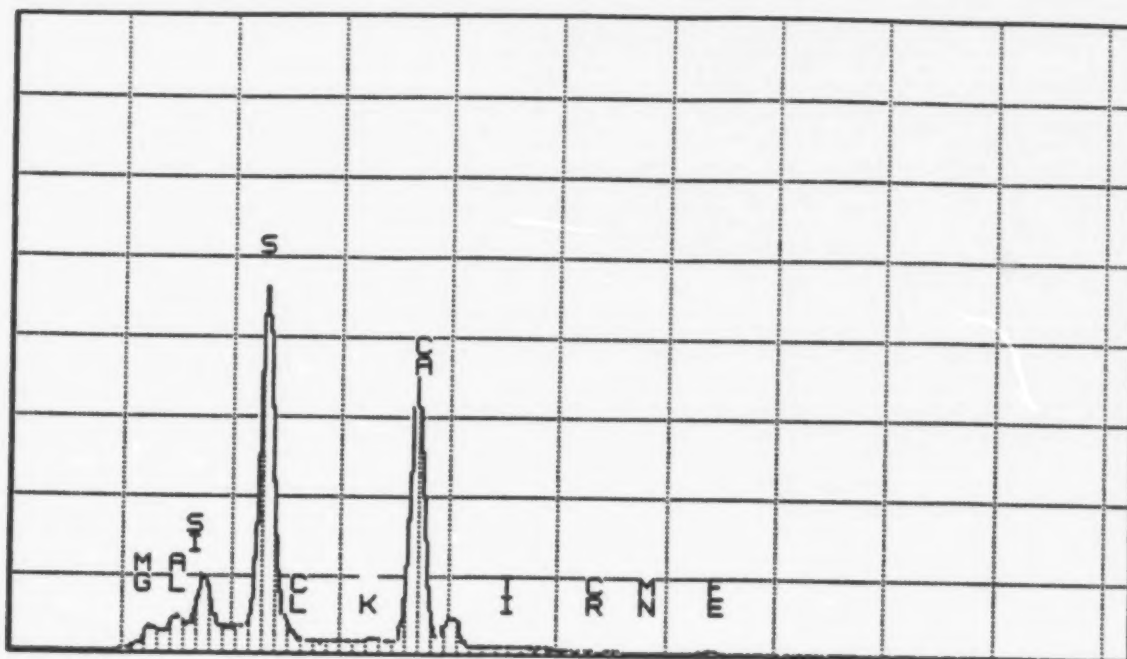
NOTE: .00 for Fe=<0.05; .00 for Mn=<0.03; .00 for NO₃=<0.2

REPORTED BY:

C. D. FISHER

SCANNING ELECTRON
MICROPROBE CHEMICAL ANALYSIS
SAMPLE S078

Cursor: 0.000keV = 0



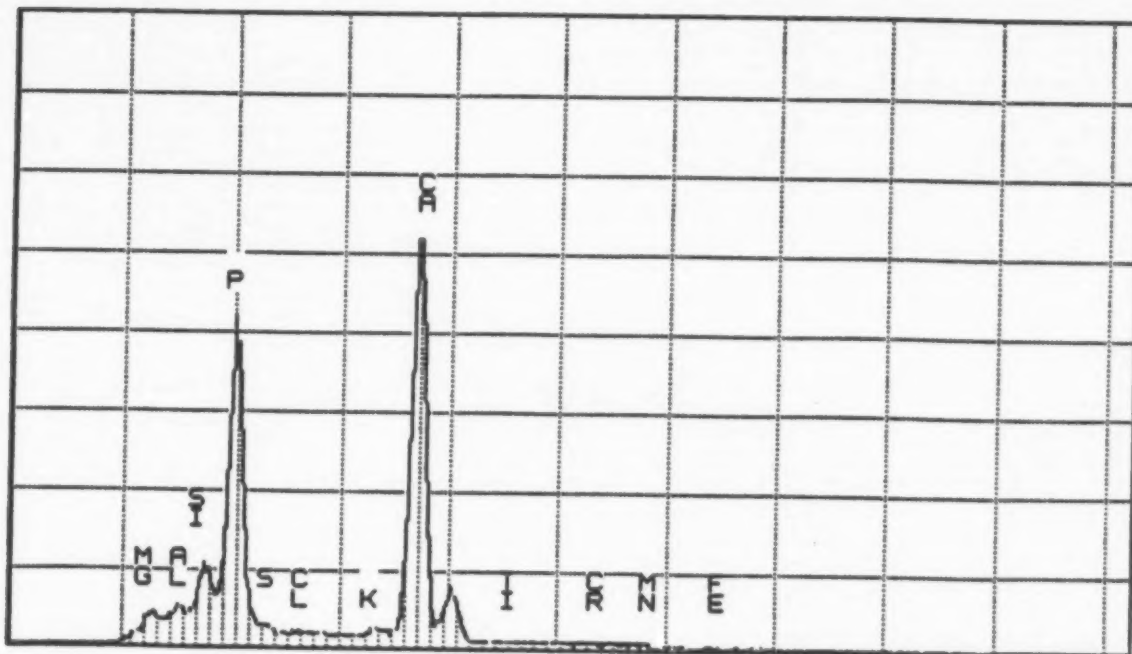
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VFS = 4096 10.240

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S078 HI ANHYDRITE

Cursor: 0.000keV = 0



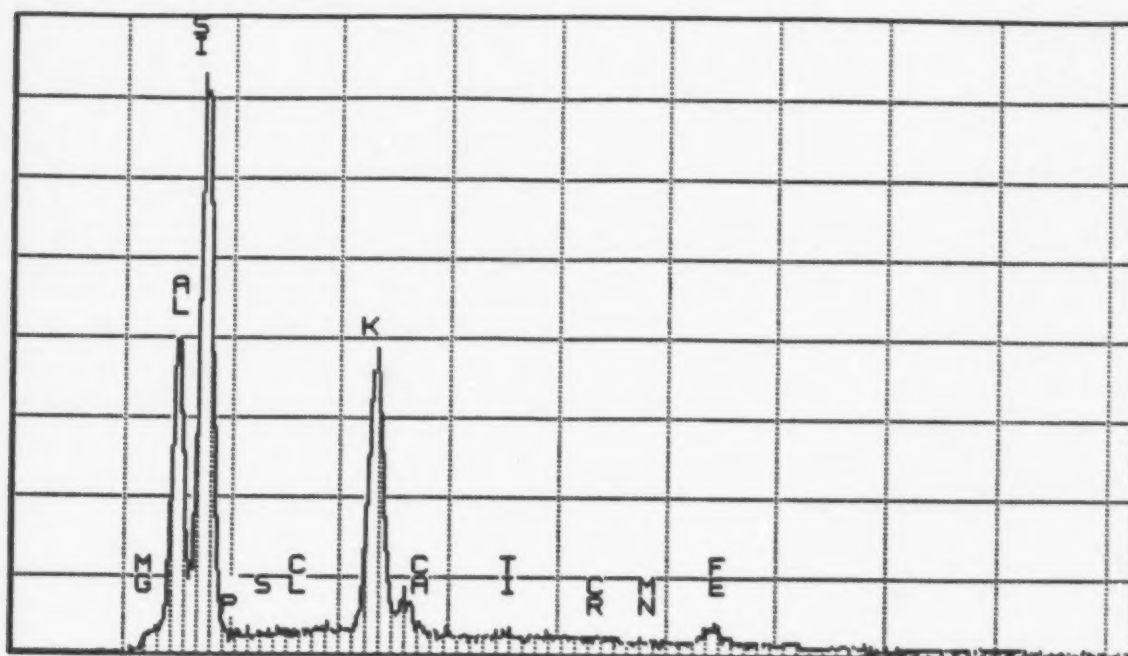
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VFS = 4096 10.240

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S078 HI APATITE

Cursor: 0.000keV = 0



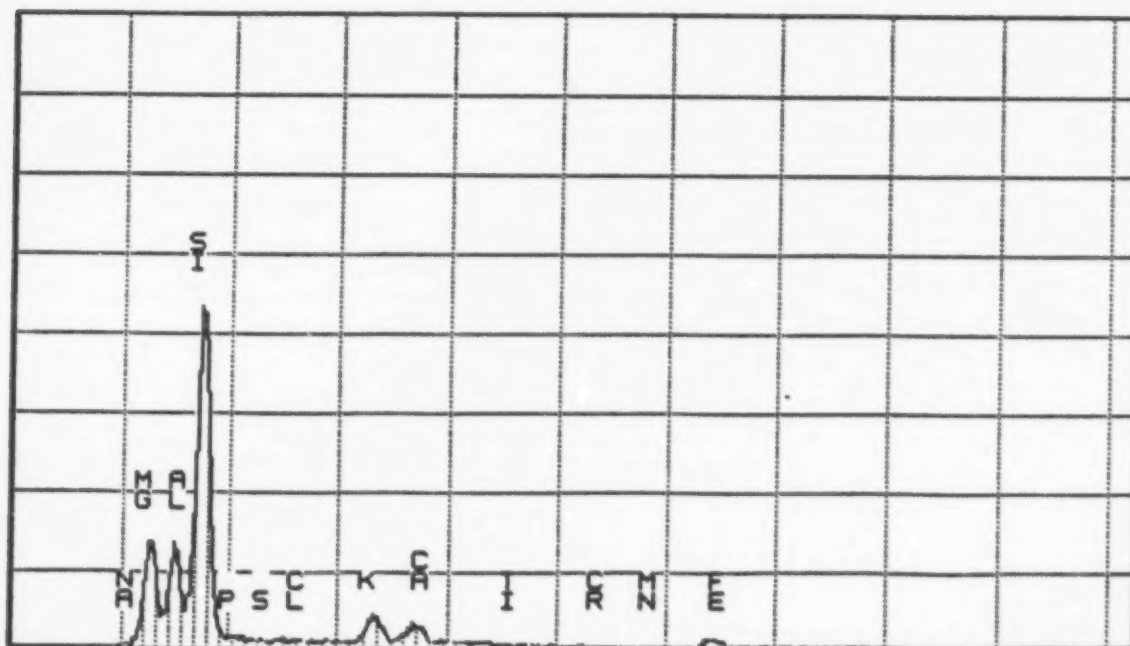
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VFS = 1024 10.240

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5078 HI ILLITE

Cursor: 0.000keV = 0



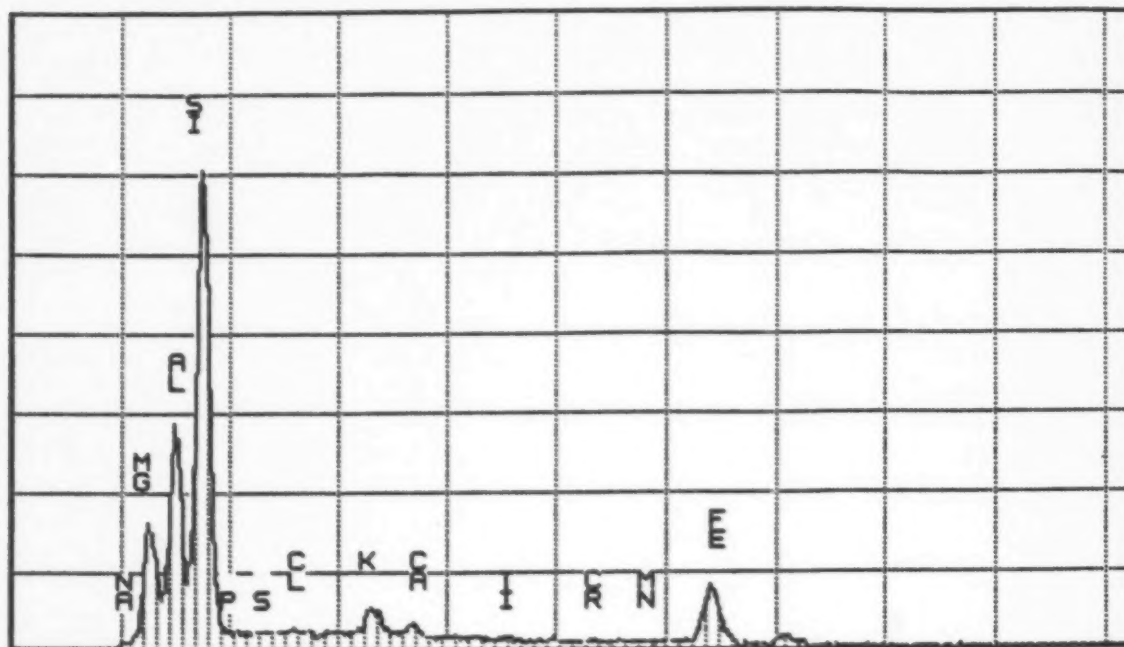
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VFS = 4096 10.240

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5078 HI COATED CLAY?

Cursor: 0.000keV = 0



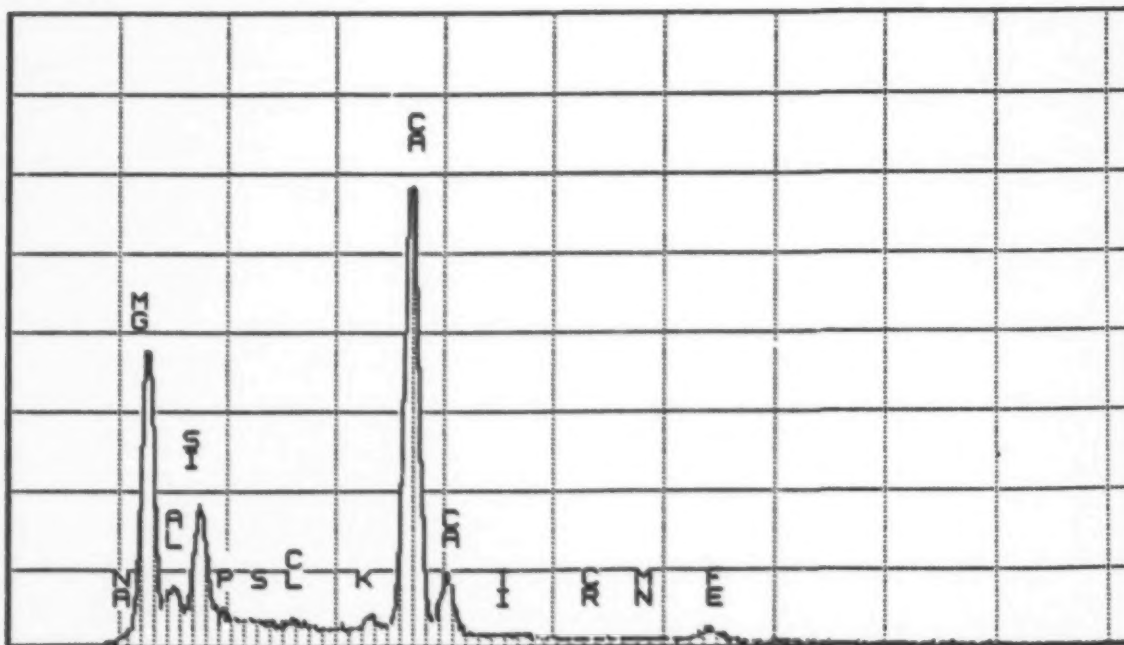
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VFS = 2048 10.240

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S078 HI CHLORITE?

Cursor: 0.000keV = 0



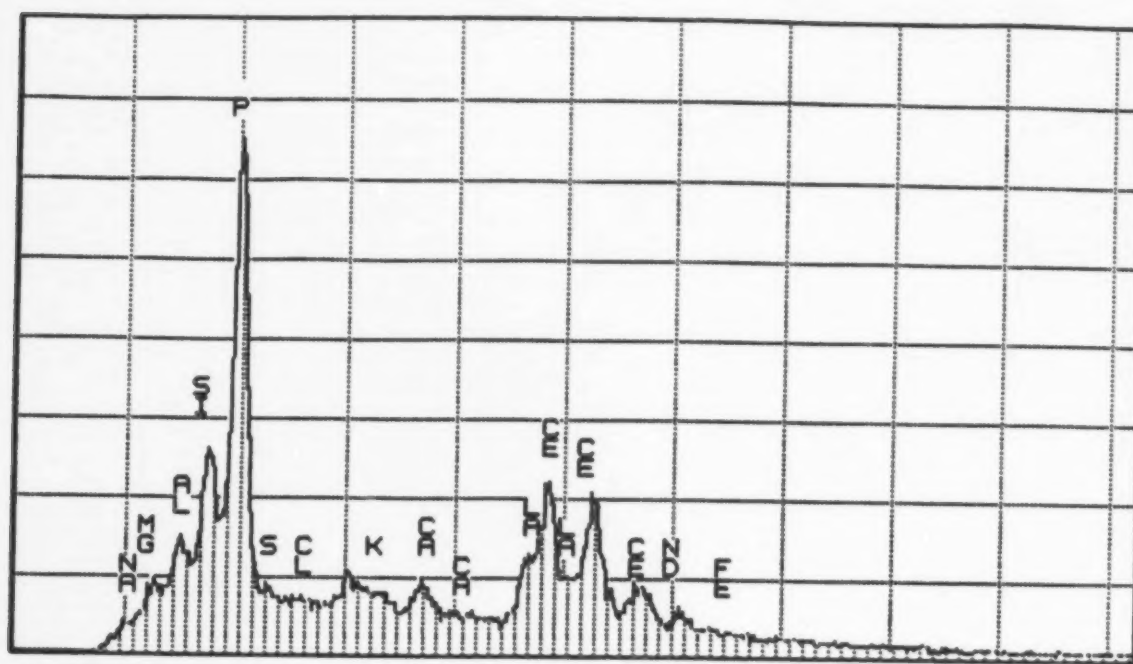
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VFS = 2048 10.240

50

S078 LO DOLOMITE MIXED WITH CLAYS

Cursor: 0.000keV = 0



0.000

VFS = 2048 10.240

50

S078 LO MONAZITE + CLAYS